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International patent application no PCT/FI2004/000160

Kansainvälinen tekemispäivä  
International filing date 19.03.2004

Keksinnön nimitys  
Title of invention

"Sulphonamide derivatives"

Täten todistetaan, että oheiset asiakirjat ovat tarkkoja jäljennöksiä kansainvälisiä patenttihakemuksia vastaanottavana viranomaisena toimivalle Patentti- ja rekisterihallitukselle alkuaan annetuista selityksestä, patenttivaatimuksista, tiivistelmästä ja piirustuksista sekä niihin tehdyistä korjauksista.

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Maksu 50 €  
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Maksu perustuu kauppa- ja teollisuusministeriön antamaan asetukseen 1027/2001 Patentti- ja rekisterihallituksen maksullisista suoritteista muutoksineen.

The fee is based on the Decree with amendments of the Ministry of Trade and Industry No. 1027/2001 concerning the chargeable services of the National Board of Patents and Registration of Finland.

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**PCT REQUEST**

Original (for SUBMISSION)

0	For receiving Office use only	PCT/FI/2004/000160
0-1	International Application No.	
0-2	International Filing Date	19 MAR 2004 (19-03-2004)
0-3	Name of receiving Office and "PCT International Application"	The Finnish Patent Office PCT International Application
0-4	Form - PCT/RO/101 PCT Request	
0-4-1	Prepared Using	PCT-SAFE [EASY mode] Version 3.50 (Build 0002.158)
0-5	Petition The undersigned requests that the present international application be processed according to the Patent Cooperation Treaty	
0-6	Receiving Office (specified by the applicant)	National Board of Patents and Registration (Finland) (RO/FI)
0-7	Applicant's or agent's file reference	2022586PC
I	Title of invention	SULPHONAMIDE DERIVATIVES
II	Applicant	
II-1	This person is:	applicant only
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II-7	State of residence	FI
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III-3-7	State of residence	
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III-4-1	This person is:	
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III-5-5	Address:	
III-5-6	State of nationality	
III-5-7	State of residence	

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III-6-1	This person is:	
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III-8	Applicant and/or inventor	applicant and inventor US only NYRÖNEN, Tommi Eerikinkatu 25 C 61 FI-00180 Espoo Finland FI FI
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III-8-5	Address:	
III-8-6	State of nationality	
III-8-7	State of residence	FI
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III-9-4	Name (LAST, First)	
III-9-5	Address:	
III-9-6	State of nationality	
III-9-7	State of residence	FI

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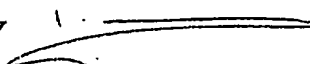
III-10	<b>Applicant and/or inventor</b>	
III-10-1	This person is:	applicant and inventor
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V	<b>DESIGNATIONS</b>	
V-1	The filing of this request constitutes under Rule 4.9(a), the designation of all Contracting States bound by the PCT on the international filing date, for the grant of every kind of protection available and, where applicable, for the grant of both regional and national patents.	
VI-1	<b>Priority claim of earlier national application</b>	
VI-1-1	Filing date	20 March 2003 (20.03.2003)
VI-1-2	Number	20030415
VI-1-3	Country	FI
VI-2	<b>Priority document request</b>	
	The receiving Office is requested to prepare and transmit to the International Bureau a certified copy of the earlier application(s) identified above as item(s):	VI-1
VII-1	<b>International Searching Authority Chosen</b>	Swedish Patent Office (ISA/SE)

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## PCT REQUEST

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VII-2	Request to use results of earlier search; reference to that search		
VII-2-1	Date	23 September 2003 (23.09.2003)	
VII-2-2	Number	20030415	
VII-2-3	Country (or regional Office)	FI	
VIII	Declarations	Number of declarations	
VIII-1	Declaration as to the identity of the inventor	-	
VIII-2	Declaration as to the applicant's entitlement, as at the international filing date, to apply for and be granted a patent	-	
VIII-3	Declaration as to the applicant's entitlement, as at the international filing date, to claim the priority of the earlier application	-	
VIII-4	Declaration of inventorship (only for the purposes of the designation of the United States of America)	-	
VIII-5	Declaration as to non-prejudicial disclosures or exceptions to lack of novelty	-	
IX	Check list	number of sheets	electronic file(s) attached
IX-1	Request (including declaration sheets)	6	✓
IX-2	Description	51	-
IX-3	Claims	3	-
IX-4	Abstract	2	✓
IX-5	Drawings	2	-
IX-7	TOTAL	64	
	Accompanying Items	paper document(s) attached	electronic file(s) attached
IX-8	Fee calculation sheet	✓	-
IX-11	Copy of general power of attorney	✓	-
IX-17	PCT-SAFE physical media	-	✓
IX-18	other:	Copy of official action	
IX-19	Figure of the drawings which should accompany the abstract		
IX-20	Language of filing of the international application	English	
X-1	Signature of applicant, agent or common representative		
X-1-1	Name:	KOLSTER OY AB	
X-1-2	Name of signatory	by  Tapio Valkeiskangas	
X-1-3	Capacity		

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## PCT REQUEST

Original (for SUBMISSION )

## FOR RECEIVING OFFICE USE ONLY

10-1	Date of actual receipt of the purported international application	19 MAR 2004 (19-03-2004)
10-2	Drawings:	
10-2-1	Received	
10-2-2	Not received	
10-3	Corrected date of actual receipt due to later but timely received papers or drawings completing the purported international application	
10-4	Date of timely receipt of the required corrections under PCT Article 11(2)	
10-5	International Searching Authority	ISA/SE
10-6	Transmittal of search copy delayed until search fee is paid	

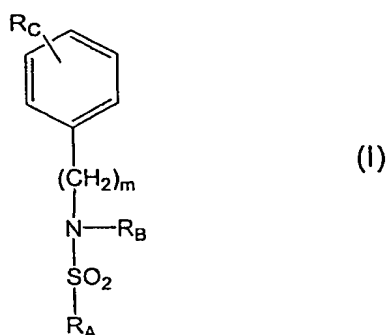
## FOR INTERNATIONAL BUREAU USE ONLY

11-1	Date of receipt of the record copy by the International Bureau	
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## Sulphonamide derivatives

### Field of the invention

The present invention relates to sulphonamide derivatives of formula (I),



where

$R_C$  is an optionally substituted 4-6-membered heterocyclic ring containing one or more N atoms, or

$R_C$  is  $-NR^1R^2$ , where

$R^1$  is hydrogen or alkyl,

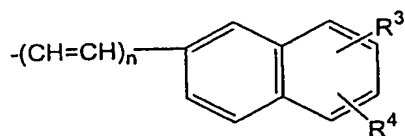
$R^2$  is alkyl or an optionally substituted 4-6-membered heterocyclic ring containing one or more N atoms, or

$R^1$  and  $R^2$  taken together with the nitrogen atom to which they are attached form a heterocyclic group, which may contain one or more additional heteroatoms selected from O and N and which may be substituted, or

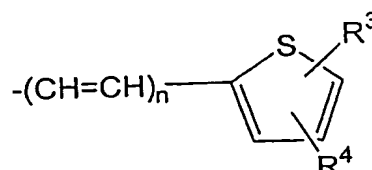
$R^1$  and  $R^2$  are absent and the nitrogen atom together with the adjacent carbon atom forms a heterocyclic ring, which may contain one or more additional heteroatoms selected from N and S and which may be substituted,

$m$  is 0 or 1,

$R_A$  is a group having the formula

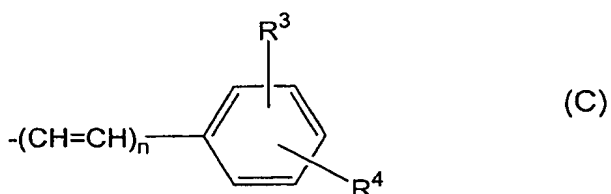


(A),



(B) or





wherein

$n$  is 0 or 1, and

$R^3$  and  $R^4$  represent each independently hydrogen, halogen, aryl, alkoxy, carboxy, hydroxy, alkoxyalkyl, alkoxycarbonyl, cyano, trifluoromethyl, alkanoylamino, trifluoromethoxy, an optionally substituted aryl or heterocyclic group, and

$R_B$  is hydrogen or alkyl.

The invention also relates to the use of the derivatives of formula (I) as inhibitors of collagen receptor integrins, especially  $\alpha 2\beta 1$  integrin inhibitors and more precisely  $\alpha 2\beta 1$  integrin I-domain inhibitors, e.g. in connection with diseases and medical conditions that involve the action of cells and platelets expressing collagen receptors, their use as a medicament, e.g. for the treatment of thrombosis and cancer spread, pharmaceutical compositions containing them and a process for preparing them.

## Background of the invention

The integrins are a large family of cell surface receptors, which mediate cell adhesion to extracellular matrix. They are composed of one  $\alpha$  and one  $\beta$  subunit that form a noncovalently bound dimer. In man there are eight  $\beta$  and eighteen  $\alpha$  subunits that can form 24 different combinations. Integrins can be divided into three subcategories, namely (i) fibronectin and vitronectin receptors, which recognize an RGD-motif in their ligands, (ii) laminin receptors, and (iii) integrins that have a special inserted-domain (I-domain) in their  $\alpha$  subunit. The I-domain integrins have been found only in Chordates (includes vertebrates), but not in Nematodes or Arthropods (Hynes *et al.*, *J. Cell Biol.*, 2000, 150:F89-96). Four out of nine I-domain integrins, namely  $\alpha 1\beta 1$ ,  $\alpha 2\beta 1$ ,  $\alpha 10\beta 1$  and  $\alpha 11\beta 1$  are collagen receptors (Gullberg *et al.*, *Prog Histochem Cytochem.*, 2002, 37:3-54). Collagens are the most abundant extracellular matrix proteins. Twenty-six collagen subtypes (types I-XXVI) are known at the moment (Myllyharju and Kivirikko, 2001, *Ann. Med.* 33:7-21). In man all four collagen receptor integrins have different expression pattern. Integrin  $\alpha 2\beta 1$  is expressed on epithelial cells, platelets, endothelial cells, fibroblasts, chondrocytes (Zutter and

Santoro, *Am. J. Pathol.*, 1990, 137:113-120), lymphocytes, mast cells (Kruger-Krasagakes *et al.*, *J. Invest. Dermatol.*, 1996, 106:538-543), and neutrophilic granulocytes (Werr *et al.*, *Blood*, 2000, 95:1804-1809). Integrin  $\alpha 2\beta 1$  deficient knock-out animals are viable, but their platelets do not react to stimulation with collagen (Chen *et al.*, *Am. J. Pathol.*, 2002, 161:337-344; Holtkotter *et al.*, *J. Biol. Chem.*, 2002, 277:10789-10794). In animal models  $\alpha 2\beta 1$  also seems to participate in cancer-related angiogenesis (Senger *et al.*, *Proc. Natl. Acad. Sci. U.S.A.*, 1997, 94:13612-13617; Senger *et al.*, *Am. J. Pathol.*, 2002, 160:195-204) and chronic inflammation (de Fougerolles *et al.*, *J. Clin. Invest.*, 2000, 105:721-729). Epidemiological studies have indicated that in man high level of  $\alpha 2\beta 1$  integrin on platelet surface is a risk factor for cerebrovascular stroke and myocardial infarction (Moshfegh *et al.*, *Lancet*, 1999, 353:351-354; Carlsson *et al.*, *Blood*, 1999, 93:3583-3586). In addition, integrin  $\alpha 2\beta 1$  is expressed on variable cancer cell types, and is involved with invasion and progression of melanoma (Klein *et al.*, *J. Invest. Dermatol.*, 1991, 96:281-284), ovarian cancer (Fishman *et al.*, *Invasion Metastasis*, 1998, 18:15-26), prostate cancer (Bonkhoff *et al.*, *Hum. Pathol.*, 1993, 24:243-248), and gastric cancer (Kawamura *et al.*, *Int. J. Oncol.*, 2001, 18:809-815).

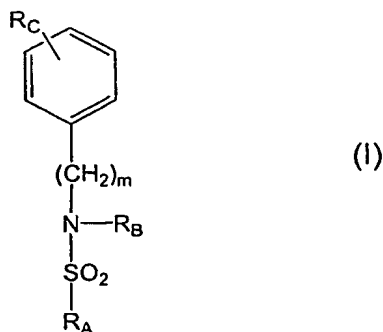
The collagen receptor integrins use their  $\alpha 1$ -domains in ligand recognition and binding. Human recombinant  $\alpha 1$ -domains have been used to analyze to molecular details of the binding mechanism (Emsley *et al.*, *Cell*, 2000, 101:47-56). In all four collagen binding  $\alpha 1$ -domains (termed as  $\alpha 11$ ,  $\alpha 21$ ,  $\alpha 101$ ,  $\alpha 111$ ) the basic structure is very similar. However,  $\alpha 1$ -domain binding assays have indicated that their ligand binding mechanisms and, for example, their ability to bind to different collagen subtypes is different (Gullberg *et al.*, *Prog Histochem Cytochem.*, 2002, 37:3-54).

One known inhibitor of  $\alpha 21$ -domain binding is a cyclic compound disclosed in the international patent publication WO 9902551.

It has now surprisingly been found that the compounds of formula (I) according to the present invention are potent inhibitors for collagen receptor integrins, especially  $\alpha 2\beta 1$  integrin, and may be used in the treatment of human diseases, such as thrombosis, cancer, fibrosis and inflammation. The compounds of formula (I) may also be used in diagnostic methods both *in vitro* and *in vivo*.

**Summary of the invention**

The present invention relates sulphonamide derivatives of formula (I),



where

$R_C$  is an optionally substituted 4-6-membered heterocyclic ring containing one or more N atoms, or  $R_C$  is  $-NR^1$ ,  $NR^2$ , where

$R^1$  is hydrogen or alkyl,

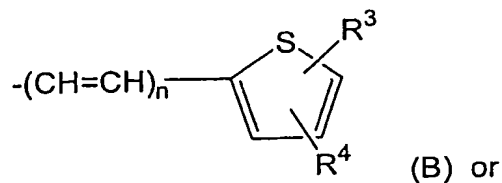
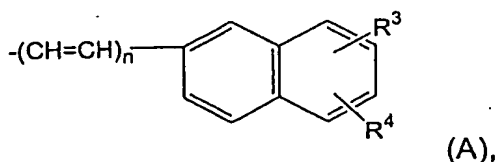
$R^2$  is alkyl or an optionally substituted 4-6-membered heterocyclic ring containing one or more N atoms, or

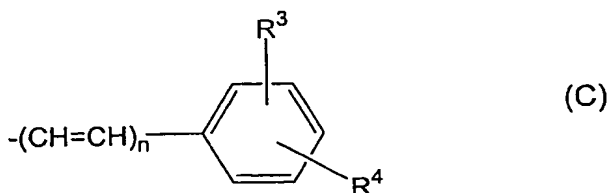
$R^1$  and  $R^2$  taken together with the nitrogen atom to which they are attached form a heterocyclic group, which may contain one or more additional heteroatoms selected from O and N and which may be substituted, or

$R^1$  and  $R^2$  are absent and the nitrogen atom together with the adjacent carbon atom forms a heterocyclic ring, which may contain one or more additional heteroatoms selected from N atoms or one S atom and which may be substituted,

$m$  is 0 or 1,

$R_A$  is a group having the formula





5

wherein

$n$  is 0 or 1, and

$R^3$  and  $R^4$  represent each independently hydrogen, halogen, aryl, alkoxy, carboxy, hydroxy, alkoxyalkyl, alkoxy carbonyl, cyano, trifluoromethyl, alkanoylamino, trifluoromethoxy, an optionally substituted aryl or heterocyclic group.

10

Further the invention relates to derivatives of formula (I) for use as inhibitors for collagen receptor integrins specifically  $\alpha 2 \beta 1$  integrin inhibitors and more precisely  $\alpha 2 \beta 1$  integrin I-domain inhibitors.

15

The invention also relates to derivatives of formula (I) for use as a medicament.

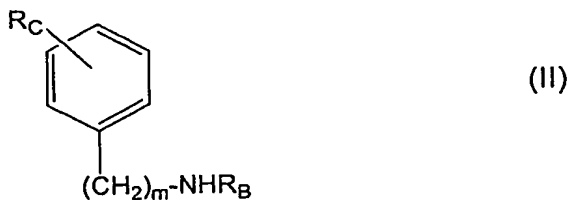
Further the invention relates to the use of a derivative of formula (I) for preparing a pharmaceutical composition for treating disorders relating to thrombosis and cancer spread.

20

The present invention also relates to a pharmaceutical composition comprising an effective amount of a derivative of formula (I) in admixture with a pharmaceutically acceptable carrier.

25

Further the invention relates to a process for preparing benzenesulphonamide derivatives of formula (I) comprising reacting a compound of formula (II),



where  $R_B$ ,  $R_C$  and  $m$  are as defined above, with a compound of formula (III),

30



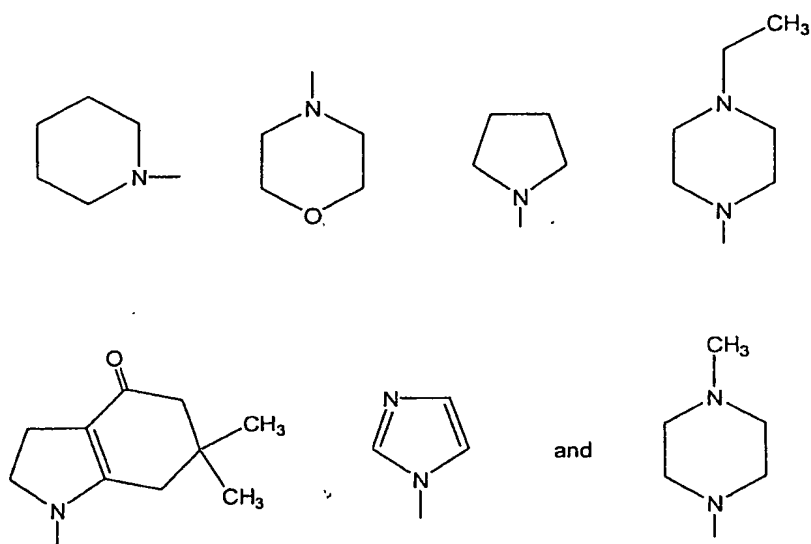
where  $R_A$  is as defined above and hal is halogen.

**Detailed description of the invention**

In the definition of the compound group of formula (I), the term "alkyl" refers to branched or straight chain alkyl groups having suitably 1 to 6 carbon atoms, preferably 1 to 3 carbon atoms, specifically methyl.

5 Examples of the meaning "4-6-membered heterocyclic ring containing at least one N atom" for  $R^2$  are pyridyl and pyrimidinyl.

Typical examples of heterocyclic groups formed by  $R^1$  and  $R^2$  together with the N atom to which they are attached are groups having formulae

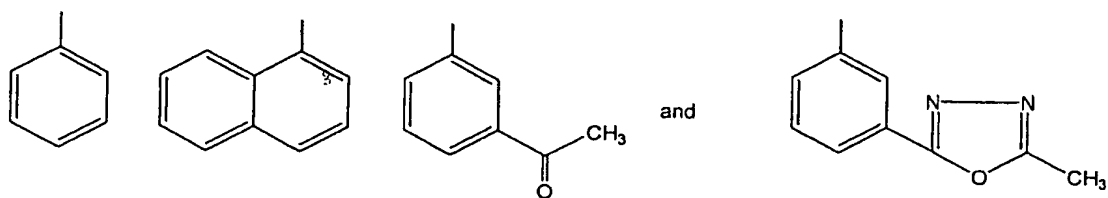


When  $R^1$  and  $R^2$  are absent the N atom may form together with the adjacent carbon atom in the phenyl ring a fused ring e.g. of formula



In formulae (A), (B) and (C) the meaning of "n" is preferably 0. Typical examples of  $R^3$  and  $R^4$  having the meaning alkoxyalkyl, alkoxycarbonyl and alkanoyl are those containing 1 to 6 carbon atoms in the alkoxy moiety and 1 to 6 carbon atoms in the alkyl moiety. Examples of optionally substituted aryl and heterocyclic groups are

20



Specific examples of preferred compounds are

5 3',4'-dimethoxy-biphenyl-3-sulphonic acid (4-dimethylamino-phenyl)-  
amide),

N-[4-(dimethylamino)phenyl]-4'-fluoro-1',1'-biphenyl-3-sulphon-  
amide,

2,4-dichloro-N-{4-[(4,6-dimethylpyrimidin-2-yl)(methyl)amino]phen-  
10 yl}benzenesulphonamide,

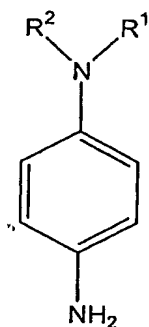
N-[4-(dimethylamino)phenyl]-3-(5-methyl-1,3,4-oxadiazol-2-yl)ben-  
zenesulphonamide,

2,4-dichloro-N-[4-(2,6,6-trimethyl-4-oxo-4,5,6,7-tetrahydro-1H-indol-  
1-yl)phenyl]benzenesulphonamide,

15 2,4-dichloro-N-(2-methyl-1,3-benzothiazol-5-yl)]benzenesulphon-  
amide,

N-[4-(dimethylamino)phenyl]-4-(1-naphtyl)benzenesulphonamide.

The compounds of formula (I) may be prepared by reacting a com-  
pound of formula (II)



(II)

20 where  $R_B$ ,  $R_C$  and  $m$  are as defined above, with a compound of for-  
mula (III)



25

where  $R_A$  is as defined above and hal is halogen.

The reaction may be carried out in conventional manner using methods well-known to the person skilled in the art.

The pharmaceutical compositions can contain one or more of the sulphonamides of the invention. The administration can be parenteral, subcutaneous, intravenous, intraarticular, intrathecal, intramuscular, intraperitoneal or intradermal injections, or by transdermal, buccal, oromucosal, ocular routes or via inhalation. Alternatively or concurrently, administration can be by the oral route. The required dosage will depend upon the severity of the condition of the patient, for example, and such criteria as the patient's weight, sex, age, and medical history. The dose can also vary depending upon whether it is to be administered in a veterinary setting to an animal or to a human patient.

For the purposes of parenteral administration, compositions containing the sulphonamides of the invention are preferably dissolved in distilled water for injection and the pH preferably adjusted to about 6 to 8 and the solution is preferably adjusted to be isotonic. If the sulphonamide is to be provided in a lyophilized form, lactose or mannitol can be added to the solution as a bulking agent and, if necessary, buffers, salts, cryoprotectants and stabilizers can also be added to the composition to facilitate the lyophilization process, the solution is then filtered, introduced into vials and lyophilized.

Useful excipients for the compositions of the invention for parenteral administration also include sterile aqueous and non-aqueous solvents. The compounds of the invention may also be administered parenterally by using suspensions and emulsions as pharmaceutical forms. Examples of useful non-aqueous solvents include propylene glycol, polyethylene glycol, vegetable oil, fish oil, and injectable organic esters. Examples of aqueous carriers include water, water-alcohol solutions, emulsions or suspensions, including saline and buffered medical parenteral vehicles including sodium chloride solution, Ringer's dextrose solution, dextrose plus sodium chloride solution, Ringer's solution containing lactose, or fixed oils. Examples of intravenous infusion vehicles include fluid and nutrient replenishers, electrolyte replenishers, such as those based upon Ringer's dextrose and the like.

Injectable preparations, such as solutions, suspensions or emulsions, may be formulated according to known art, using suitable dispersing or wetting agents and suspending agents, as needed. When the active compounds are in water-soluble form, for example, in the form of water soluble salts, the sterile injectable preparation may employ a non-toxic parenterally ac-

ceptable diluent or solvent as, for example, water for injection (USP). Among the other acceptable vehicles and solvents that may be employed are 5% dextrose solution, Ringer's solution and isotonic sodium chloride solution (as described in the Ph. Eur. / USP). When the active compounds are in a non-water  
5 soluble form, sterile, appropriate lipophilic solvents or vehicles, such as fatty oil, for example, sesame oil, or synthetic fatty acid esters, for example, ethyl oleate or triglycerides, are used. Alternatively, aqueous injection suspensions which contain substances which increase the viscosity, for example, sodium carboxymethyl cellulose, sorbitol, and/or dextran, and optionally also contain  
10 stabilizers may be used.

Pharmaceutical preparations for oral (but systemic) administration can be obtained by combining the active compounds with solid excipients, optionally granulating a resulting mixture and processing the mixture or granules or solid mixture without granulating, after adding suitable auxiliaries, if desired  
15 or necessary, to give tablets or capsules after filling into hard capsules.

Suitable excipients are, in particular, fillers such as sugars, for example lactose or sucrose, mannitol or sorbitol, cellulose and/or starch preparations and/or calcium phosphates, for example tricalcium phosphate or calcium hydrogen phosphate, as well as binders, such as starches and their derivatives, pastes, using, for example, maize starch, wheat starch, rice starch, or  
20 potato starch, gelatine, tragacanth, methyl cellulose, hydroxypropylmethyl cellulose, sodium carboxymethyl cellulose, and/or polyvinyl pyrrolidone, derivatives, and/or, if desired, disintegrating agents, such as the above-mentioned starches, and also carboxymethyl-starch, cross-linked polyvinyl pyrrolidone, agar or alginic acid or a salt thereof, such as sodium alginate. Auxiliaries are, above all, flow-regulating agents and lubricants, for example, silica, talc, stearic acid or salts thereof, such as magnesium stearate or calcium stearate, with suitable coating, which if desired, are resistant to gastric juices and for this purpose, *inter alia* concentrated sugar solutions, which optionally contain gum  
25 arabic, talc, polyvinyl pyrrolidone, polyethylene glycol and/or titanium dioxide, lacquer solutions and suitable organic solvents or solvent mixtures, but also film coating using cellulose derivatives, polyethylene glycols and/or PVP derivatives may be used. In order to produce coatings resistant to gastric juices, solutions of suitable cellulose preparations such as acetyl cellulose phthalate  
30 or hydroxypropylmethyl cellulose phthalate, are used for coating. Dyestuffs or pigments may be added to the tablets or dragee coatings, for example, for



identification or in order to characterize different combinations of active compound doses.

Solid dosage forms for oral administration include capsules, tablets, pills, troches, lozenges, powders and granules. In such solid dosage forms, the active compound may be admixed with at least one inert diluent such as sucrose, lactose or starch. Such dosage forms may also comprise, as is normal practice, pharmaceutical adjuvant substances, e.g., stearate lubricating agents or flavouring agents. Solid oral preparations can also be prepared with enteric or other coatings which modulate release of the active ingredients.

Liquid dosage forms for oral administration include pharmaceutically acceptable emulsions, solutions, suspensions, syrups and elixirs containing inert non-toxic diluents commonly used in the art, such as water and alcohol. Such compositions may also comprise adjuvants, such as wetting agents, emulsifying, suspending, sweetening and flavouring agents.

The compositions of the invention may also be administered by means of pumps, or in sustained-release form. The compounds of the invention may also be delivered to specific organs in high concentration by means of suitably inserted catheters, or by providing such molecules as a part of a chimeric molecule (or complex) which is designed to target specific organs.

Administration in a sustained-release form is more convenient for the patient when repeated injections for prolonged periods of time are indicated so as to maximize the comfort of the patient. Controlled release preparation can be achieved by the use of polymers to complex or adsorb the peptides of the invention. Controlled delivery can be achieved by selecting appropriate macromolecules (for example, polyesters, polyamino acids, polyvinyl pyrrolidone, ethylenevinylacetate, methylcellulose, carboxymethylcellulose, protamine zinc and protamine sulfate) as well as the method of incorporation in order to control release. Another possible method to control the duration of action by controlled release preparations is to incorporate the desired peptide into particles of a polymeric material such as polyesters, polyamino acids, hydrogels, poly (lactic acid) or ethylene vinylacetate copolymers. Alternatively, instead of incorporating the sulphonamide into these polymeric particles, the sulphonamide can be entrapped into microparticles, prepared, for example, by coacervation techniques or by interfacial polymerization, for example, hydroxymethylcellulose or gelatin-microcapsules and poly (methylmethacrylate) microcapsules, respectively, or in colloidal drug delivery systems, for example

liposomes, albumin microspheres, microemulsions, nanoparticles, and nanocapsules or in macroemulsions. The above-mentioned technics may be applied to both parenteral and oral administration of the pharmaceutical formulation.

5           The sulphonamides that are used in the compositions and methods of the invention can be employed in dosage forms such as tablets, coated tablets, capsules, powder sachets, or liquid solutions for oral administration if the biological activity of the material is not destroyed by the digestive process and if the characteristics of the compound allow it to be absorbed across the intestinal tissue.

10           The pharmaceutical compositions of the present invention can be manufactured in a manner which is in itself known, for example, by means of conventional mixing, granulating, dragee-making, dissolving, lyophilizing or similar processes.

15           The compounds of the invention are potent collagen receptor inhibitors and useful for inhibiting or preventing the adhesion of cells on collagen or the migration and invasion of cells through collagen, *in vivo* or *in vitro*. The now described compounds inhibit the migration of malignant cells and are thus for treating diseases such as cancers, including prostate, and melanoma, especially where  $\alpha 2\beta 1$  integrin dependent cell adhesion/invasion/migration may contribute to the malignant mechanism.

20           The compounds of the invention also inhibit adhesion of platelets to collagen and collagen-induced platelet aggregation. Thus, the compounds of the invention are useful for treating patients in need of preventative or ameliorative treatment for conditions or diseases such as cardio-vascular diseases that are characterized by a need to prevent adhesion of platelets to collagen and collagen-induced platelet aggregation, for example, in stroke victims or patients at risk of having a stroke.

#### Pharmacological tests

30   **A cell invasion assay was used to demonstrate the anti-cancer potential of the inhibitors *in vitro***

          The ability to interact with extracellular matrix basement membranes is essential for the malignant cancer cell phenotype and cancer spread.  $\alpha 2\beta 1$  levels are known to be upregulated in tumorigenic cells. The overexpression  
35   regulates cell adhesion and migration to and invasion through the extracellular

matrix. By blocking the interaction between extracellular matrix components like collagen and  $\alpha 2\beta 1$  it is possible to block cancer cell migration and invasion *in vitro*. Prostate cancer cells (PC-3) expressing  $\alpha 2\beta 1$  endogenously were used to test the *in vitro* anticancer potential of the inhibitors of the present invention.

### Experimental procedure

Invasion of PC-3 cells (CRL-1435, ATCC) through Matrigel was studied using BD Biocoat invasion inserts (BD Biosciences). Inserts were stored at  $-20^{\circ}\text{C}$ . Before the experiments inserts were allowed to adjust to the room temperature. 500  $\mu\text{l}$  of serum free media (Ham's F12K medium, 2 mM L-glutamine, 1.5 g/l sodium bicarbonate) was added into the inserts and allowed to rehydrate at  $37^{\circ}\text{C}$  in cell incubator for two hours. The remaining media was aspirated. PC-3 cells were detached, pelleted and suspended into serum free media (50 000 cells / 500  $\mu\text{l}$ ). 300  $\mu\text{l}$  of cell suspension was added into the insert in the absence (control) or presence of the inhibitor according to the present invention. Inserts were placed on the 24-well plates; each well containing 700  $\mu\text{l}$  of cell culture media with 3% of fetal bovine serum as chemo-attractant. Cells were allowed to invade for 72 hours at  $37^{\circ}\text{C}$  in cell incubator. Inserts were washed with 700  $\mu\text{l}$  PBS, and fixed with 4 % paraformaldehyde for 10 minutes. Paraformaldehyde was aspirated and cells were washed with 700  $\mu\text{l}$  of PBS and inserts were stained by incubation with hematoxylin for 1 minute. The stain was removed by washing the inserts with 700  $\mu\text{l}$  of PBS. Inserts were allowed to dry. Fixed invaded cells were calculated under the microscope. Invasion % was calculated as a comparison to the control. The results are presented in attached Figure 1.

### A platelet function analyzer PFA100 was used to demonstrate the antithrombotic potential of the $\alpha 2\beta 1$ inhibitors

A platelet function analyzer PFA 100 was used to demonstrate the possible antithrombotic effects of  $\alpha 2\beta 1$  inhibitors. The PFA 100 is a high shear-inducing device that simulates primary hemostasis after injury of a small vessel. The system comprises a test-cartridge containing a biologically active membrane coated with collagen plus ADP. An anticoagulated whole blood sample was run through a capillary under a constant vacuum. The platelet agonist (ADP) on the membrane and the high shear rate resulted in activation of platelet aggregation, leading to occlusion of the aperture with a stable plate-

let plug. The time required to obtain full occlusion of the aperture was designated as the "closure time". Each hit compound was added to the whole blood sample and the closure time was measured with PFA 100. If the closure time was increased when compared to the control sample the hit compound was suggested to have antithrombotic activity.

### Experimental procedure

Blood was collected from a single donor via venipuncture into evacuated blood collection tubes containing lithium heparin as anticoagulant. Within 30 minutes, blood was aliquoted into 50 mL falcon tubes and treated with either inhibitory compounds (e.g. mAbs P1H5, 5E8, P1E6) or, as controls, non-specific rat IgG or PBS only at pH 7.4. All experimental and control compounds were diluted in PBS before addition to 0.5% total volume (i.e. 15.92 mL blood and 80  $\mu$ l compound in PBS). Samples were kept at room temperature with rotation for the duration of the experiments. Duplicate sample volumes (800  $\mu$ l) were dispensed into PFA Collagen/ADP cartridges, and individual closure times were determined.

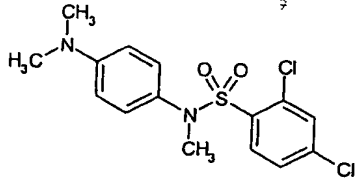
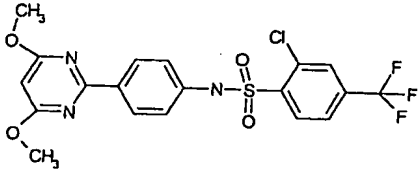
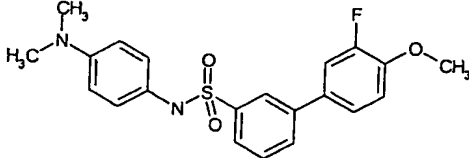
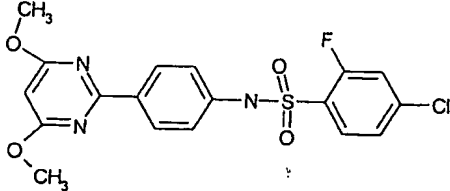
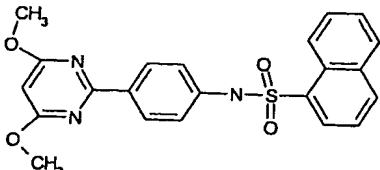
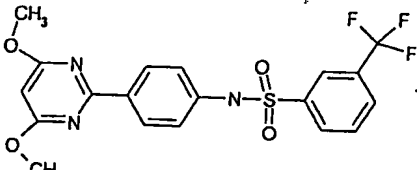
Control and experimental samples were tested in two or three sequences during the interval of 60 to 180 minutes from draw. This practice allowed the observation of increasing inhibitory effects over time.

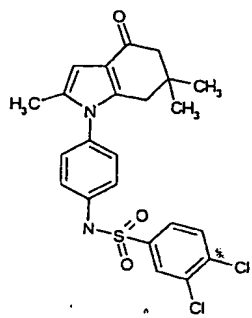
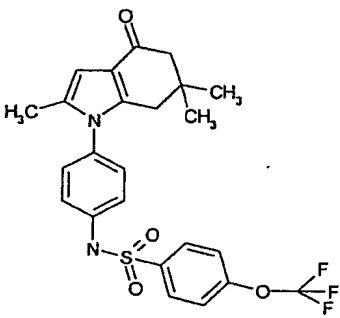
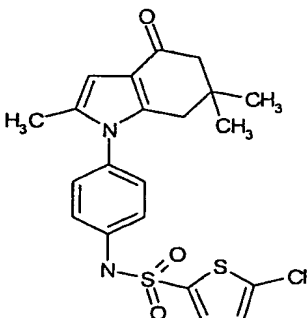
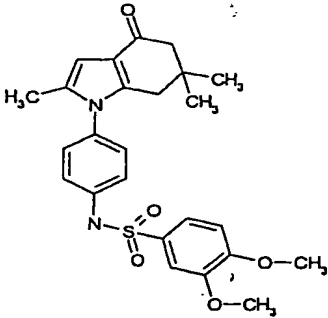
Acquisitions resulting in a closure time exceeding the range of measurement of the instrument (>300 seconds) were assigned a value of 300 seconds. Mean and standard deviations were calculated for each treatment, and data points falling outside  $\pm 2$  SD of the mean were excluded. Student's t-test was applied to the resultant data. The results are presented in attached Figure 2.

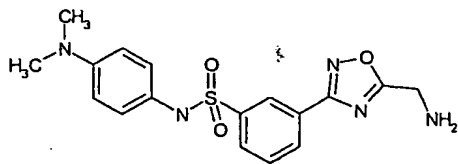
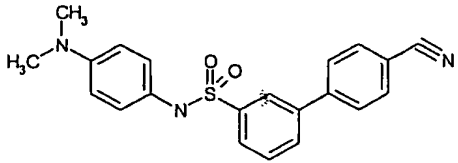
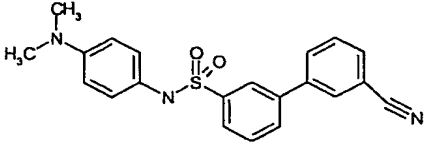
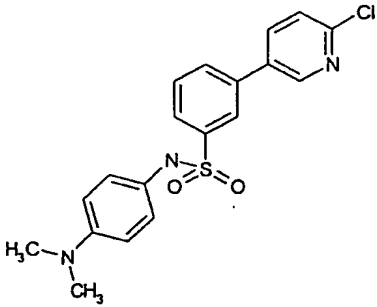
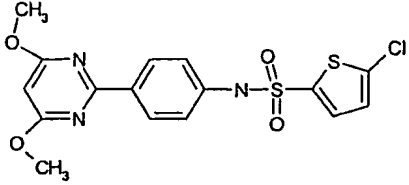
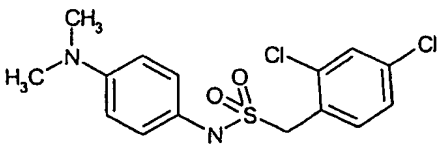
Figures 1 and 2 contain results with coded compounds BTT-3001 = 2,4-dichloro-N-{4-[(4,6-dimethylpyrimidin-2-yl)(methyl)amino]phenyl}benzenesulphonamide, compound BTT-3002 = 3',4'-dimethoxy-biphenyl-3-sulphonic acid (4-dimethylamino-phenyl)-amide and compound BTT-3003 = N-[4-(dimethylamino)phenyl]-4'-fluoro-1',1'-biphenyl-3-sulphonamide.

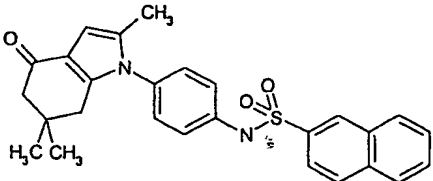
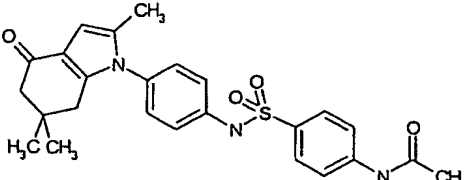
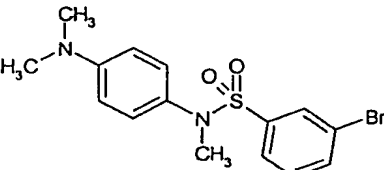
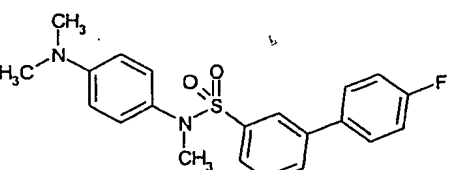
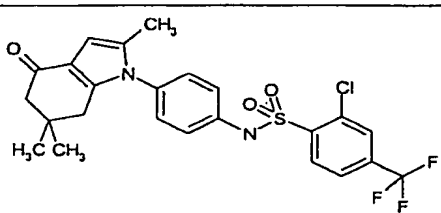
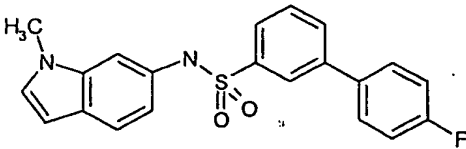
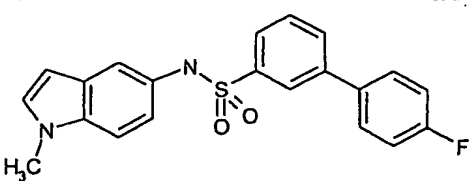
Further, the compounds listed in Table 1 and Table 1B below were tested. The results are presented in Table 2.

Table 1

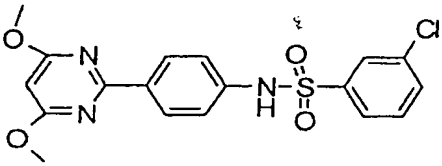
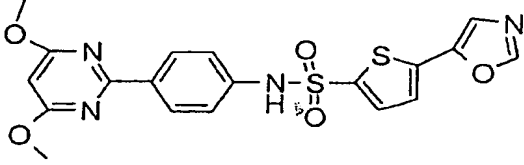
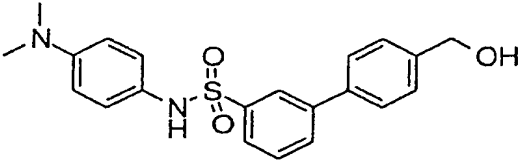
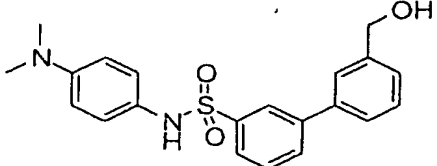
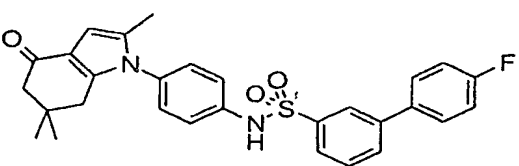
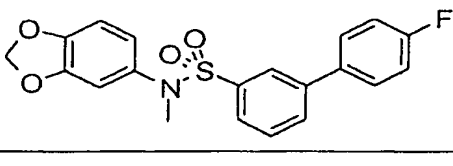
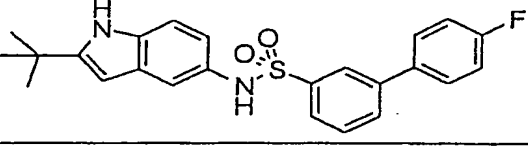
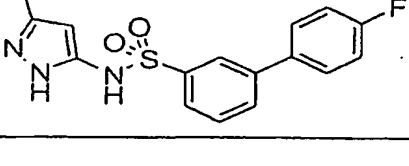
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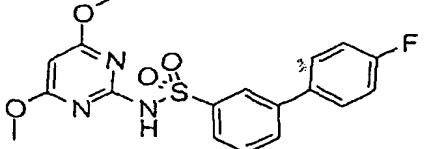
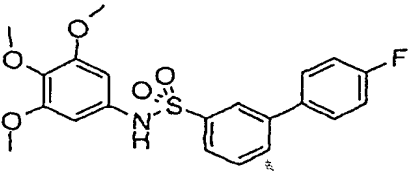
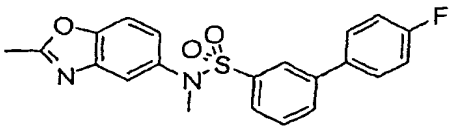
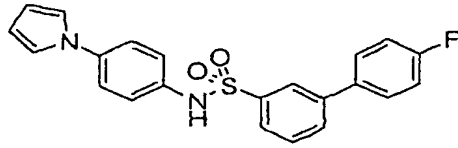
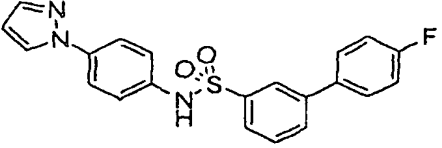
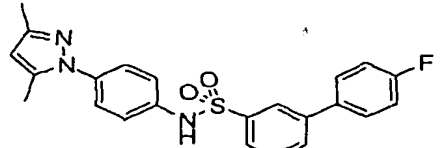
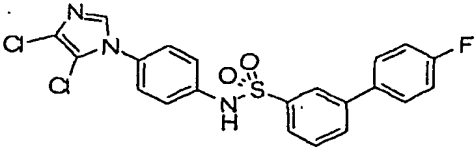
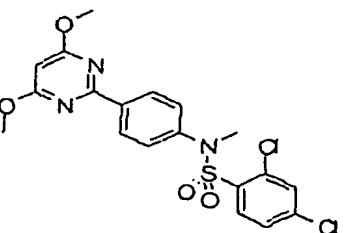
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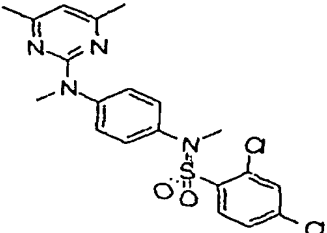
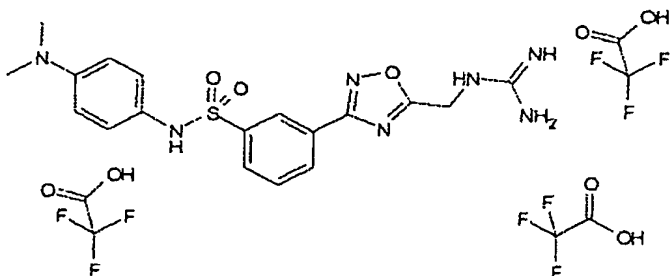
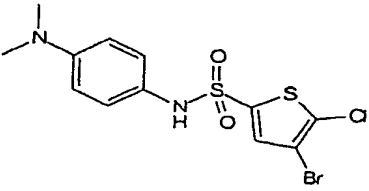
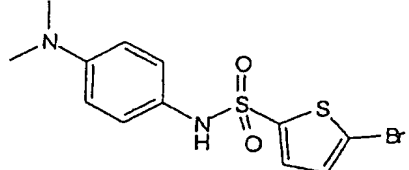
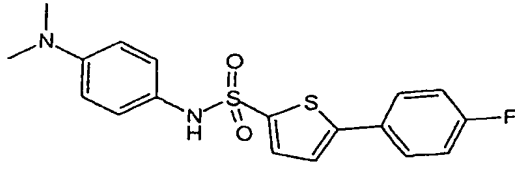
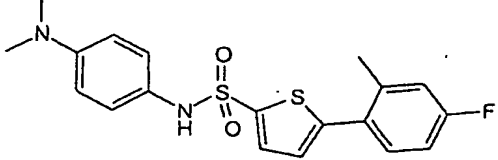
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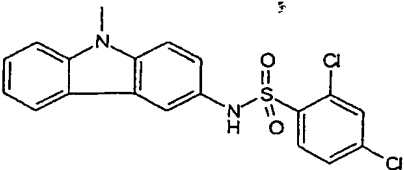
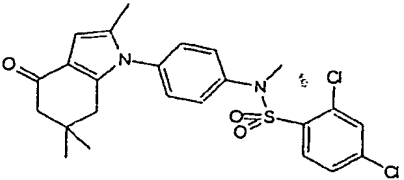
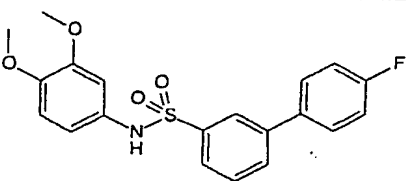
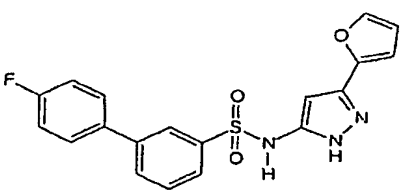
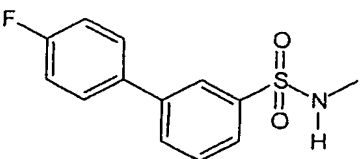
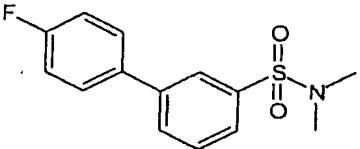
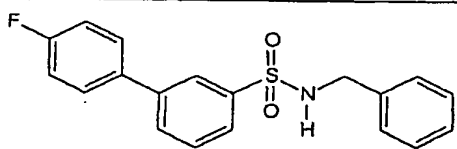
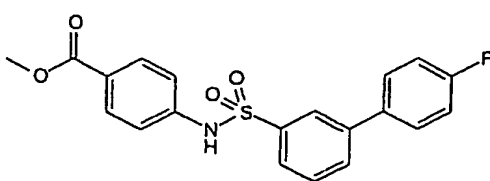
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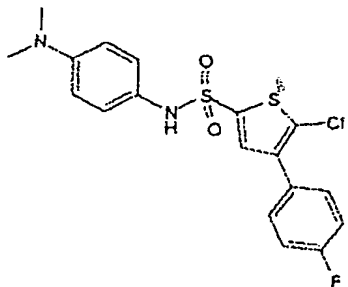
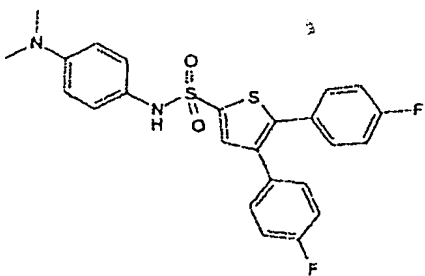
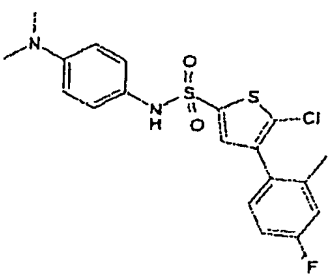
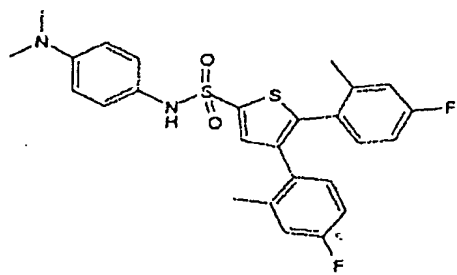
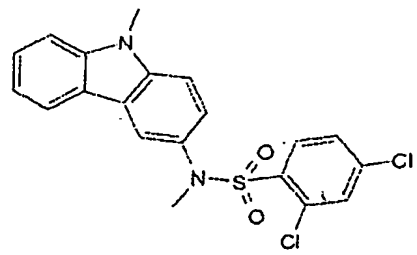


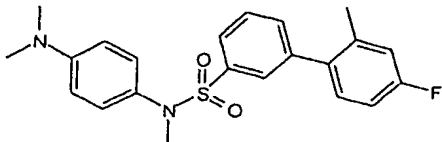
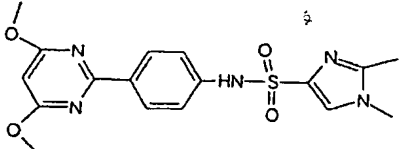
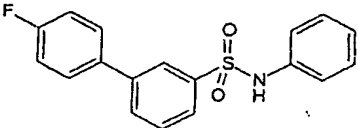
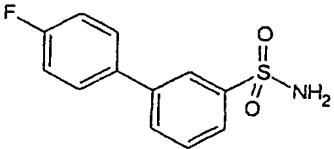
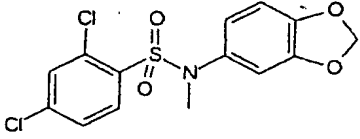
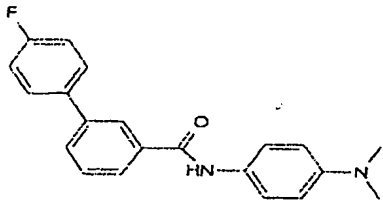
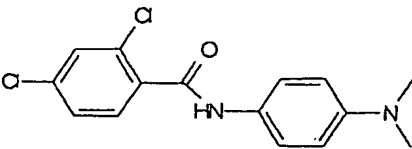
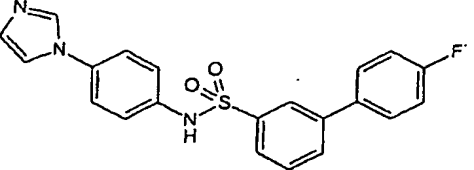
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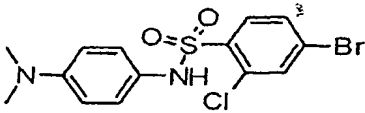
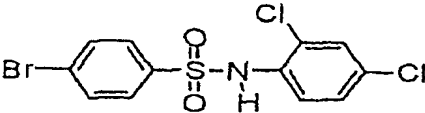
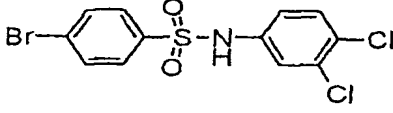
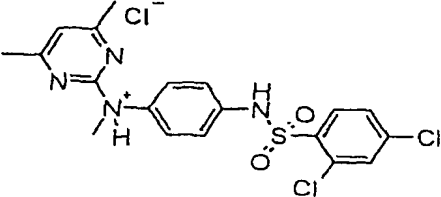
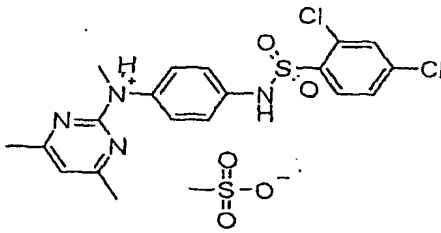
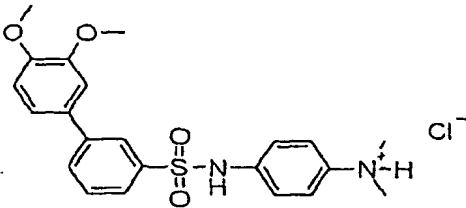
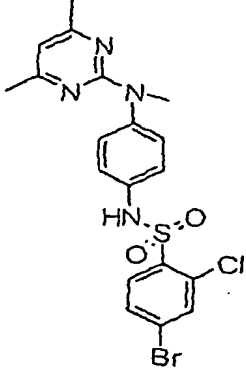
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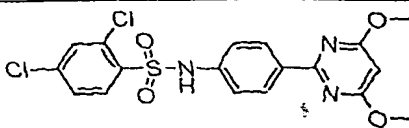
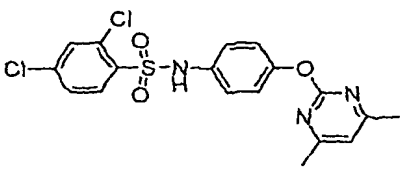
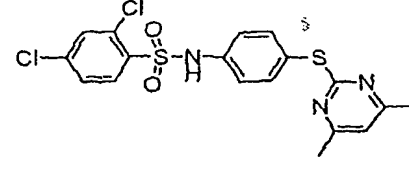
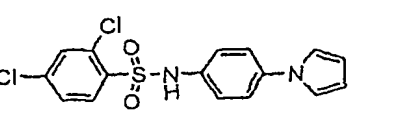
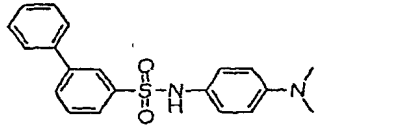
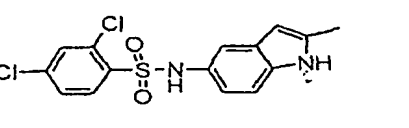
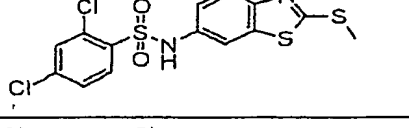
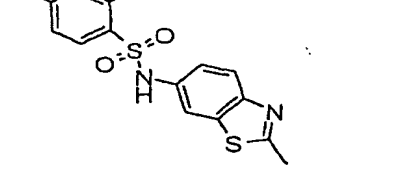
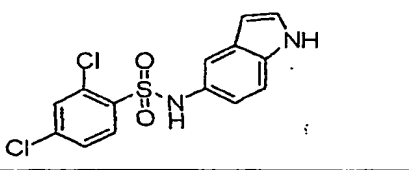
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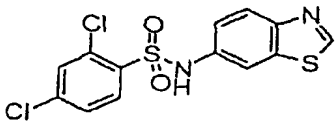
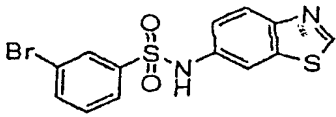
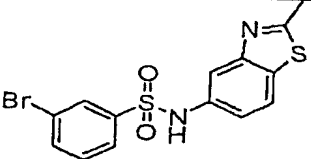
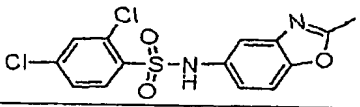
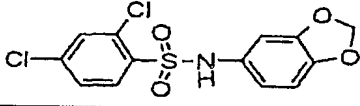
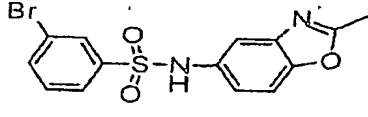
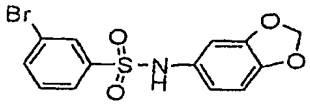
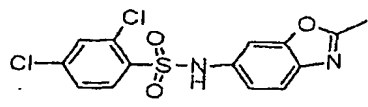
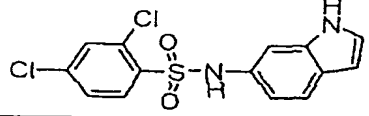
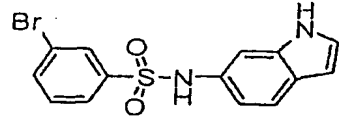
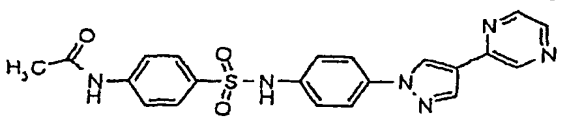
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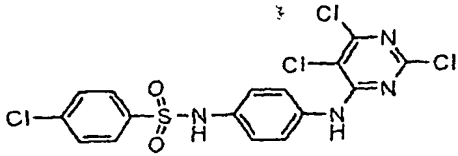
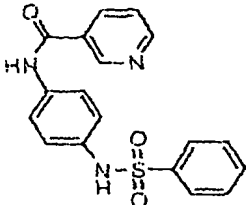
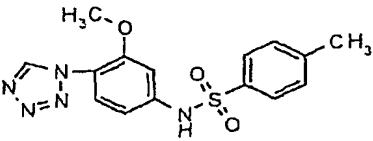
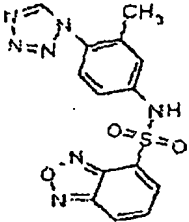
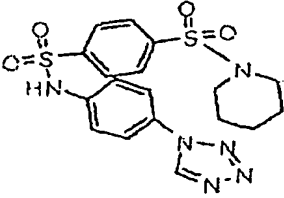
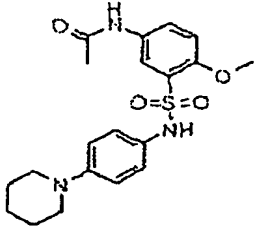
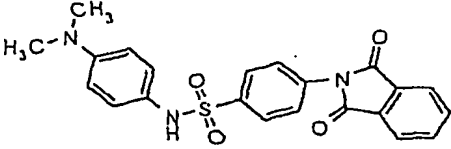
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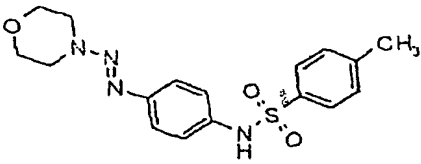
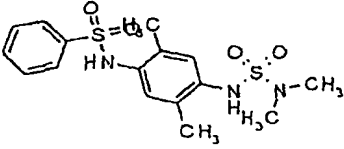
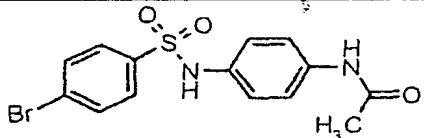
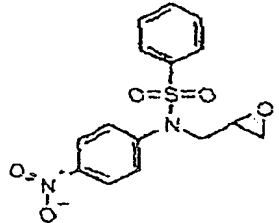
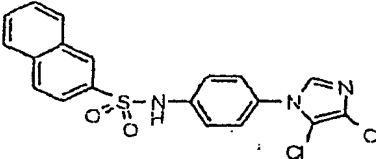
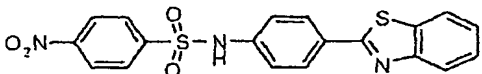
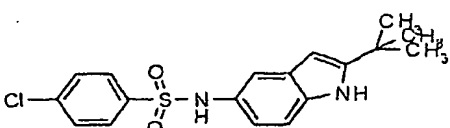
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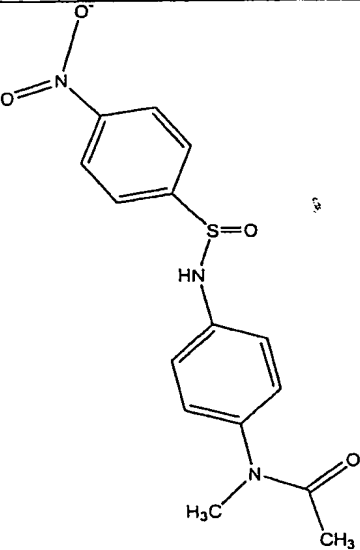
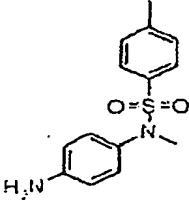
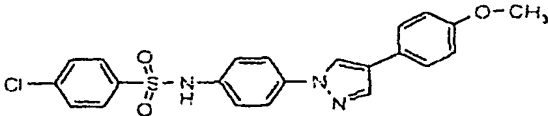
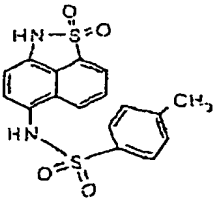
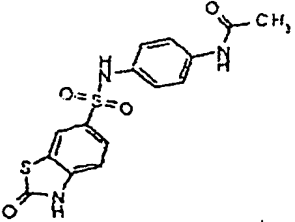
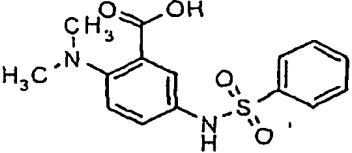
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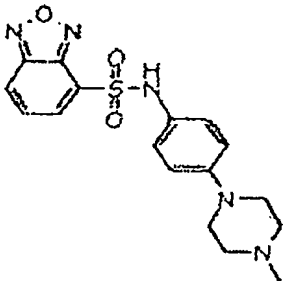
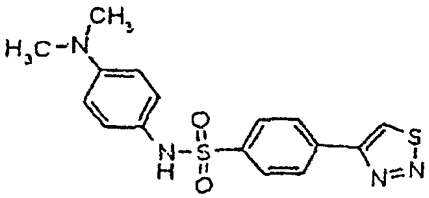
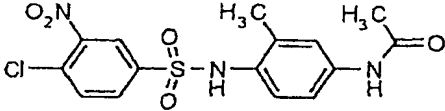
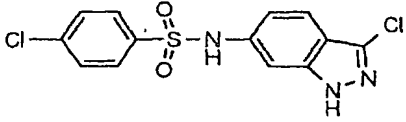
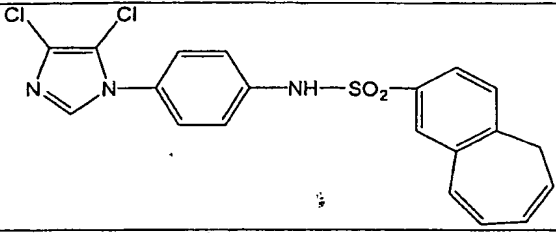
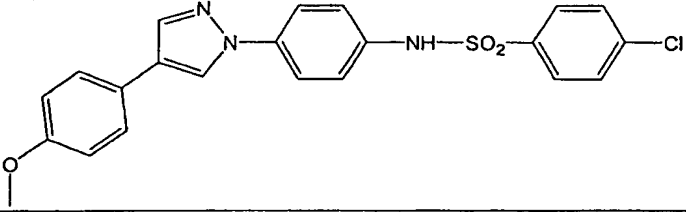
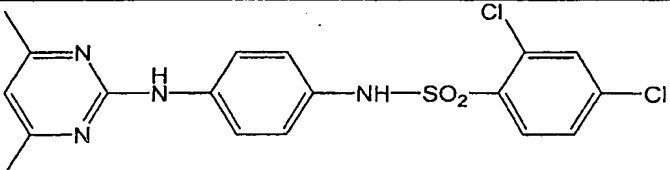
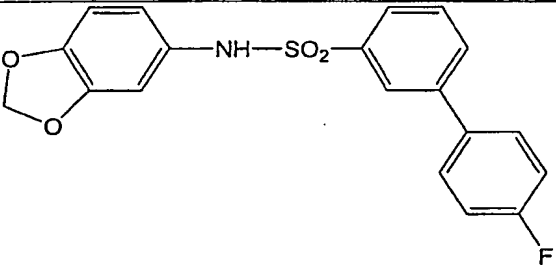
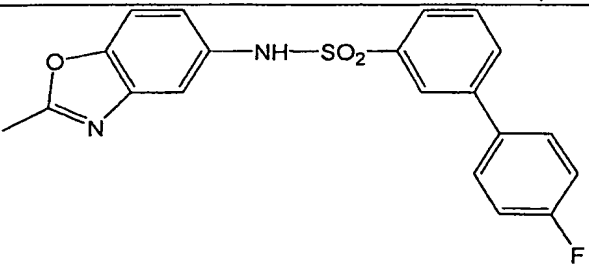
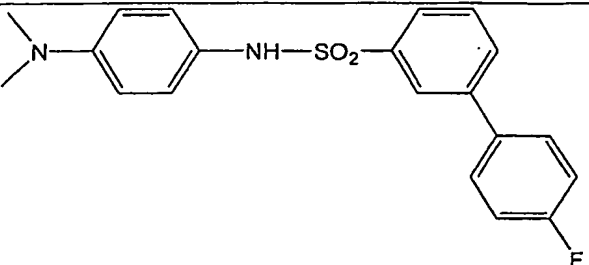
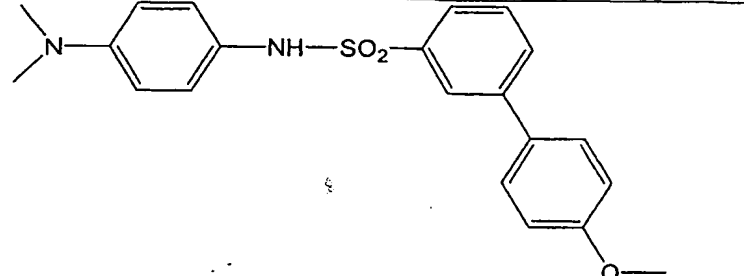
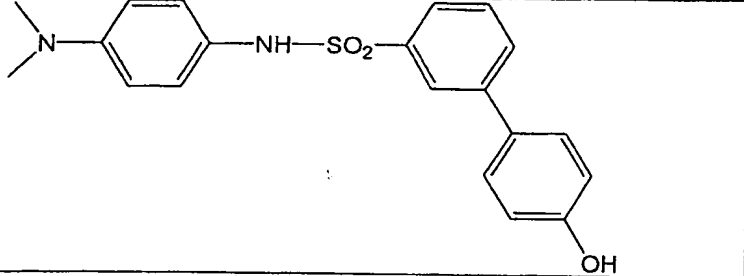
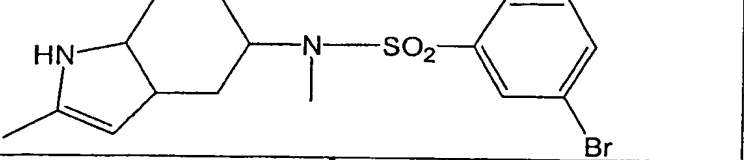
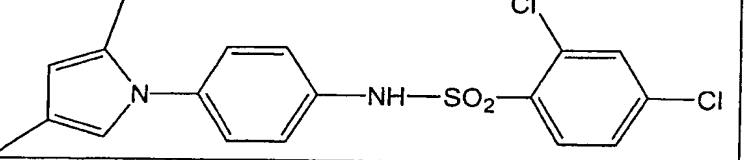
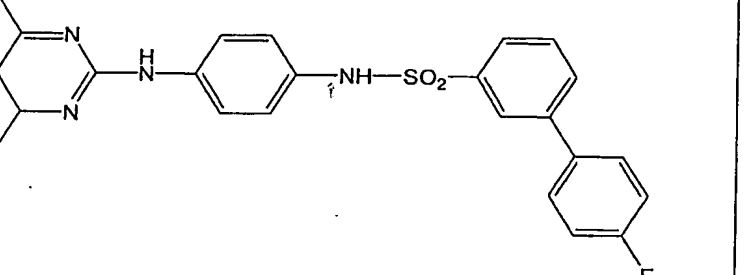
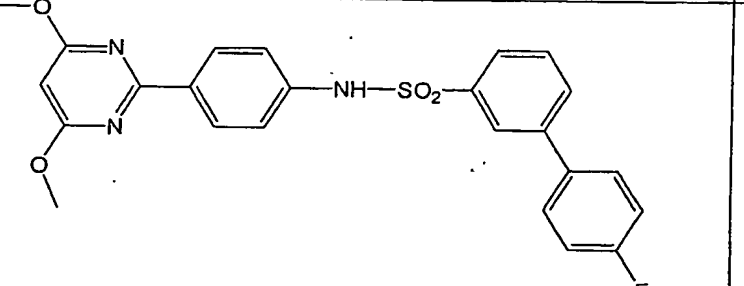
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Table 1B

Structure	NCE number
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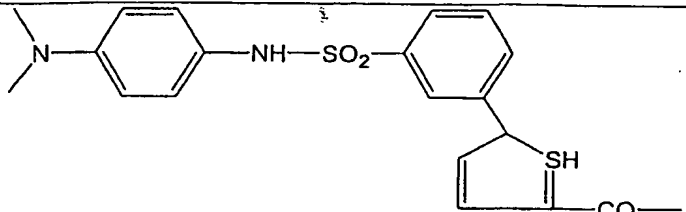
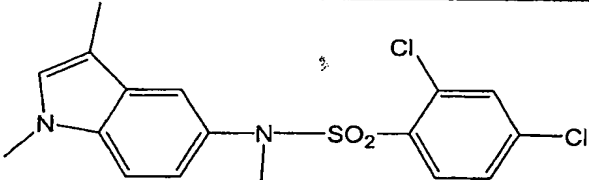
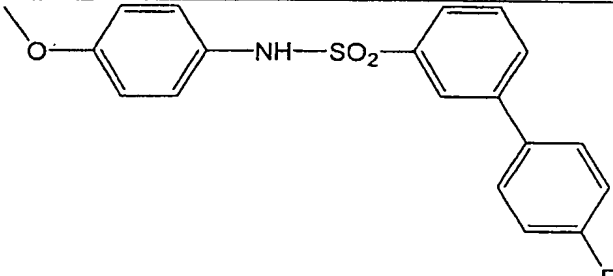
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Table 2

Compound	EC50 in cell adhesion assay	E <sub>max</sub> in cell adhesion assay
NCE131	25 $\mu$ M	58 %
NCE132	40 $\mu$ M	90 %
NCE134	10 $\mu$ M	40 %
NCE139	46 $\mu$ M	75 %
NCE142	20 $\mu$ M	77 %
NCE161	34 $\mu$ M	82 %
NCE163	32 $\mu$ M	66 % at 50 $\mu$ M
NCE164	21 $\mu$ M	85 % at 50 $\mu$ M
NCE170	24 $\mu$ M	85 % at 40 $\mu$ M
NCE171	20 $\mu$ M	79 %
NCE173	35 $\mu$ M	59 % at 40 $\mu$ M
NCE176	17 $\mu$ M	59 % at 50 $\mu$ M
NCE182	25 $\mu$ M	77 %
NCE183	28 $\mu$ M	81 %
NCE186	19 $\mu$ M	91 %
NCE187	18 $\mu$ M	87 %
NCE188	36 $\mu$ M	81 %
NCE189	30 $\mu$ M	76 %
NCE190	25 $\mu$ M	76 %
NCE192	39 $\mu$ M	75 %
NCE193	22 $\mu$ M	72 %
NCE195	49 $\mu$ M	60 %
NCE197	30 $\mu$ M	74 %
NCE202	27 $\mu$ M	91 %
NCE203	19 $\mu$ M	86 %
NCE204	~25 $\mu$ M (could not be defined by Prism)	63 %
NCE205	20 $\mu$ M	84 % (50 $\mu$ M)
NCE209	35 $\mu$ M	64 % (50 $\mu$ M)
NCE210	dd could not be detected	80 % (50 $\mu$ M)
NCE213	25 $\mu$ M	71 % (50 $\mu$ M)

NCE201	36 $\mu$ M	64 % (50 $\mu$ M)
NCE222	15 $\mu$ M	66 %
NCE223	13 $\mu$ M	82 %
NCE230	>30 $\mu$ M (could not be defined by Prism)	76 % (at 50 $\mu$ M)
NCE234	35 $\mu$ M	85 %
NCE235	20 $\mu$ M	85 %
NCE239	24 $\mu$ M	64 % (at 50 $\mu$ M)
NCE242	6 $\mu$ M	70 %
NCE250	31 $\mu$ M	89 %
NCE255	17 $\mu$ M	88 % (at 50 $\mu$ M)
NCE258	40 $\mu$ M	66 %
NCE263	26 $\mu$ M	88 %
NCE266	18 $\mu$ M	70 %
NCE269	19 $\mu$ M	64 %
NCE275	26 $\mu$ M	57 %
NCE281	47 $\mu$ M	78 %
NCE282	1.6 $\mu$ M	59% (at 50 $\mu$ M)
NCE283	23 $\mu$ M	63 %
NCE284	~30 $\mu$ M	69 %
NCE285	20 $\mu$ M	60 % (at 50 $\mu$ M)
NCE286	37 $\mu$ M	72 %
NCE291	32 $\mu$ M	50 %
NCE295	29 $\mu$ M	56 %
NCE297	26 $\mu$ M	80 %
NCE298	33 $\mu$ M	79 %
NCE299	9.6 $\mu$ M	79 %
NCE302	24 $\mu$ M	57 %
NCE306	24 $\mu$ M	67 % (at 50 $\mu$ M)
NCE307	20 $\mu$ M	67 % (at 50 $\mu$ M)
NCE300	45 $\mu$ M	50 %
NCE316	10 $\mu$ M	87 % (at 50 $\mu$ M)
NCE317	44 $\mu$ M	45 %
NCE320	10 $\mu$ M	45 %
NCE321	6.3 $\mu$ M	55 %

The test results showed that the compounds of the present invention have an anti-cancer and antithrombotic activity *in vitro*.

The following examples illustrate the invention but are not intended to limitate the scope of the invention.

## 5 Example 1

### 3-bromo-N-[4-(dimethylamino)phenyl]benzenesulphonamide

To a solution of 4-dimethylamino aniline (2 g, 0.0147 mol) and triethylamine (2.25 mL, 0.0162 mol, 1.1 eq.) in acetonitrile (20 mL) at 0°C under nitrogen was added dropwise a solution of 3-bromobenzene sulphonyl chloride  
10 (3.94 g, 0.0154 mol, 1.05 eq.) in acetonitrile (5 mL). The mixture was allowed to warm to room temperature and stirred for 18 hours. The solvent was removed *in vacuo* and the residue redissolved in ethyl acetate (100 mL). The organic layer was washed with sat aqueous NaHC-O<sub>3</sub> (2x200 mL), water (2x200 mL), brine (200 mL), dried (Na<sub>2</sub>SO<sub>4</sub>), filtered and concentrated. The product  
15 was obtained as a brown solid (3.5g, 67.0%) and was not purified further.

<sup>1</sup>H NMR (300 MHz d<sub>6</sub> DMSO) δ 7.78 — 7.76 (s, 2ff), 7.61 — 7.58 (d, 1H), 7.48 — 7.43 (t, 1H), 6.84 — 6.80 (d, 2H), 6.57 — 6.54 (d, 2H), 2.78 (s, 6H); <sup>13</sup>C NMR (300 MHz d<sub>6</sub> DMSO) δ 148.84, 142.15, 135.70, 131.65, 129.46, 126.12, 125.66, 124.77, 122.24, 112.95; LCMS R<sub>t</sub> 15.44 min.; *m/z* — 353.3.  
20 MP 187-189°C.

## Example 2

### 3',4'-dimethoxy-biphenyl-3-sulphonic acid (4-dimethylamino-phenyl)-amide (BTT-3002)

To a solution of 3-bromo-N-(4-dimethylamino-phenyl)-benzenesulphonamide (2.14 g, 6.02 mmol) and 3,4-dimethoxyphenyl-boronic acid (1.09 g, 6.02 mmol) in toluene (200 mL) and aqueous sodium carbonate solution (2 M, 100 mL) under N<sub>2</sub> was added tetrakis (triphenylphosphine) palladium (0) (80 mg). The mixture was stirred under reflux for 18 hours. The reaction mixture was then filtered through celite and washed with ethyl acetate. The organic layer was separated and dried (MgSO<sub>4</sub>). After evaporation of the solvent  
30 the crude material was purified by column chromatography (SiO<sub>2</sub>, ethylacetate/cyclohexane = 4/6) to yield 1.8 g (73%) of NCE-102 as light yellow crystals: mp 43°C. <sup>1</sup>H NMR (300 MHz, CDCl<sub>3</sub>) 8.2.93 (6 H, s), 3.94 (6 H, s), 6.19 (1

H, bs), 6.60 (2 H, d,  $J = 9$  Hz), 6.9 (4 H, m), 7.09 (1 H, d,  $J = 9$  Hz), 7.46 (1 H, t,  $J = 8.8$  Hz), 7.64 (1 H, d,  $J = 9$  Hz), 7.5 (1 H, d,  $J = 8.8$  Hz, CH), 7.87 (1 H, s);  $^{13}\text{C}$  NMR (300 MHz,  $\text{CDCl}_3$ ) 840.88, 56.42, 56.45, 110.77, 112.01, 113.04, 120.05, 124.97, 125.76, 125.87, 126.80, 129.59, 131.18, 132.61, 140.21, 142.15, 149.76, 149.81; MS (ES<sup>+</sup>)  $m/z$  413.5 (M + H).

### Example 3

#### N-[4-(dimethylamino)phenyl]-4'-fluoro-1,1'-biphenyl-3-sulphonamide (BTT-3003)

Crude compound of example 1 (3.98 g, 11.2 mmol), 4-fluorobenzene boronic acid (1.57 g, 11.2 mmol) and tetrakis (triphenylphosphine) palladium (160 mg, 0.14 mmol) were stirred in toluene (150 mL, degassed) and 2M sodium bicarbonate solution (100 mL, degassed) at 106°C overnight. After this time the reaction mixture was filtered through celite, the organic solution separated from the aqueous, which was washed with ethyl acetate and the organic solvents combined. The crude dark brown/black material was decoloured with activated charcoal and recrystallised from isopropanol to give the product (1.8324 g, 44%) as an off white/beige material: mp 158-160°C;  $^1\text{H}$  NMR ( $\text{CDCl}_3$ )  $\delta$  3.03 (s, 6H), 6.69 (s, 1H), 6.72 (s, 2H), 7.05 — 7.08 (d,  $J = 9$  Hz, 2H), 7.19 — 7.24 (t,  $J = 8.7$  Hz, 2H), 7.52 — 7.62 (m, 3H), 7.79 — 7.81 (m, 2H), 7.94-7.95 (m, 1H);  $^{13}\text{C}$  NMR ( $\text{CDCl}_3$ )  $\delta$  40.93, 113.14, 116.085, 116.372, 125.02, 126.23, 126.71, 129.28, 129.73, 131.35, 135.81, 140.25, 141.30, 149.86, 161.64, 164.93, LCMS  $R_f = 15.0$  mins, (ES) =  $m/z$  371.3 (M + 1).

### Example 4

#### 2,4-dichloro-N-{4-[(4,6-dimethylpyrimidin-2-yl)(methyl)amino]phenyl}benzenesulphonamide (BTT-3001)

To a solution of N-(4,6-dimethylpyrimidin-2-yl)-N-methylbenzene-1,4-diamine (2 g, 0.0088 mol) and triethylamine (1.35 mL, 0.0097 mol, 1.1 eq.) in acetonitrile (30 mL) at 0°C under nitrogen was added dropwise a solution of 2,4-dichlorobenzene sulphonyl chloride (2.26 g, 0.0092 mol, 1.05 eq.) in acetonitrile (10 mL). The mixture was allowed to warm to room temperature and stirred for 18 hours. The solvent was removed *in vacuo* and the residue redissolved in ethyl acetate (100 mL). The organic layer was washed with sat aqueous  $\text{NaHCO}_3$  (2x100 mL), water (2x100 mL), brine (100 mL), dried ( $\text{Na}_2\text{SO}_4$ ),

filtered and concentrated. The residue was purified by column chromatography (1:4 AcOEt:cyclohexane) to yield 1.26 g of a yellow oil (bis sulphonamide) and 1.77 g (46.2%) of a light green solid (monosulphonamide).

*Bis sulphonamide:*  $^1\text{H}$  NMR (300 MHz  $\text{CDCl}_3$ )  $\delta$  8.13 — 8.10 (d, 2H), 7.52 — 7.51 (d, 2H), 7.43 — 7.38 (dd, 1H), 7.37 — 7.34 (d, 2H), 7.26 — 7.22 (d, 2H), 6.43 (s, 1H), 3.56 (s, 3H), 2.29 (s, 6H).

*Monosulphonamide:*  $^1\text{H}$  NMR (300 MHz  $\text{CDCl}_3$ )  $\delta$  7.88 — 7.85 (d, 1H), 7.46 (d, 1H), 7.26 — 7.22 (dd, 1H), 7.18 — 7.14 (d, 2H), 7.01 — 6.98 (d, 2H), 6.87 (s, NH), 6.29 (s, 1H), 3.40 (s, 3H), 2.18 (s, 6H);  $^{13}\text{C}$  NMR (300 MHz  $\text{CDCl}_3$ )  $\delta$  167.35, 144.51, 140.29, 135.53, 133.39, 131.78, 131.59, 127.97, 126.99, 123.02, 110.88, 38.46, 24.39; LCMS  $R_t$  18.71 min.;  $m/z$  — 437.4.

### Example 5

#### Hydrolysis of the 2,4-dichloro-N-[(2,4-dichlorophenyl)sulphonyl]-N-{4-[(4,6-dimethylpyrimidin-2-yl)(methyl)amino]phenyl}benzenesulphonamide

To a solution of the bis sulphonamide (1.26 g, 0.002 mol) in ethanol (50 mL) was added NaOEt (653 mg, 0.0097 mol, 5 eq.) and the reaction was heated to 65°C for 5 hrs. The solvent was removed *in vacuo* and residue dissolved in water. The aqueous layer was washed twice with  $\text{CHCl}_3$  (50 mL). The organic layers were combined, dried ( $\text{Na}_2\text{SO}_4$ ), filtered and concentrated. The solid was purified by column chromatography (1:4 — 2:3 AcOEt:cyclohexane) to yield a beige solid (550 mg, 64.7%, 2,4-dichloro-N-{4-[(4,6-dimethylpyrimidin-2-yl)(methyl)amino]phenyl}benzenesulphonamide).

$^1\text{H}$  NMR (300 MHz  $\text{CDCl}_3$ )  $\delta$  7.88 — 7.87 (d, 1H), 7.46 (d, 1H), 7.26 — 7.22 (dd, 1H), 7.18 — 7.14 (d, 2H), 7.02 — 6.97 (d, 2H), 6.90 (s, NH), 6.28 (s, 1H), 3.40 (s, 3H), 2.17 (s, 6H);  $^{13}\text{C}$  NMR (300 MHz  $\text{CDCl}_3$ )  $\delta$  167.36, 144.49, 140.28, 135.54, 133.39, 131.72, 131.61, 127.97, 127.00, 123.00, 110.88, 38.47, 24.39; LCMS  $R_t$  18.71 min.;  $m/z$  — 437.4.

LCMS conditions: 0-97% acetonitrile in water, C18, electrospray +ve.

**Example 6****N-[4-(dimethylamino)phenyl]-3-(5-methyl-1,3,4-oxadiazol-2-yl)benzene-sulphonamide**

To a solution of 4-dimethyl amino aniline (0.05 g, 0.367 mmol) and triethylamine (0.056 mL, 0.404 mmol, 1.1 eq.) in acetonitrile (2 mL) under nitrogen was added 3-(5-methyl-1,3,4-oxadiazol-2-yl) benzene sulphonyl chloride (0.0997 g, 0.385 mmol, 1.05 eq.) in acetonitrile (2 mL). The mixture was shaken at room temperature for 18 hours. The solvent was removed *in vacuo*. The residue was re-dissolved in AcOEt and the organic layer washed with saturated aqueous NaHCO<sub>3</sub>, separated, dried (Na<sub>2</sub>SO<sub>4</sub>) and concentrated *in vacuo*. The residue was analysed by LCMS and was shown to be mainly product (R<sub>t</sub> 9.97 min; *m/z* — 359.3). The residue was purified by MS-directed prep HPLC to give the sulphonamide as a black solid (5.6 mg).

<sup>1</sup>H NMR (300 MHz CDCl<sub>3</sub>/d<sub>4</sub> MeOH (2 drops))  $\delta$  8.29 — 8.27 (m, 1H), 8.04 — 8.01 (m, 1H), 7.97 — 7.94 (m, 1H), 7.81 — 7.75 (m, 1H), 7.52 — 7.46 (t, 1H), 7.02 — 6.97 (m, 4H), 2.96 (s, 6H), 2.67 (s, 3H); Purity - >95%.

**Example 7****2,4-dichloro-N-[4-(2,6,6-trimethyl-4-oxo-4,5,6,7-tetrahydro-1H-indol-1-yl)-phenyl]benzenesulphonamide**

To bromo wang resin in DMF (4 ml) was added 1-(4-aminophenyl)-2, 6, 6-trimethyl-5,6,7-trihydroindol-4-one (0.375 g, 1.40 mmol, 5 eq.), sodium iodide (0.210 g, 1.40 mmol, 5 eq.) and diisopropylethylamine (0.500 ml, 2.80 mmol, 10 eq.). The resin was shaken at 90°C for 24hrs. The resin was filtered and washed with 5ml of DMF, DCM, DMF, DCM, MeOH, DCM, MeOH and finally Et<sub>2</sub>O. The resin was dried under vacuum.

To the resin was added pyridine (3 ml), 2,4-dichlorobenzene sulphonyl chloride (0.430 g, 1.75 mmol, 5 eq.) and DMAP (0.085 g, 0.700 mmol, 2 eq.). The resin was shaken at 60°C for 18hrs and washed with 5ml of DMF, DCM, DMF, DCM, MeOH, DCM, MeOH and finally Et<sub>2</sub>O.

The resin was shaken in a solution of 95% TFA / 5% H<sub>2</sub>O (3 ml) for 24hrs, filtered and the resin washed with DCM (1 ml) and MeOH (1 ml). The combined filtrates were concentrated *in vacuo*. The residue was purified by MS-directed prep HPLC to give the sulphonamide (1.1 mg).

LCMS R<sub>t</sub> 11.46 min.; *m/z* — 478; Purity -85%.

**Example 8****2,4-dichloro-N-(2-methyl-1,3-benzothiazol-5-yl)benzenesulphonamide**

To a solution of 2-methyl-1, 3-benzothiazol-5-amine (0.05 g, 0.211 mmol, 1 eq.) in acetonitrile (2 ml) was added triethyl amine (0.059 ml, 0.232 mmol, 1.1 eq.) and 2,4 dichlorobenzene sulphonyl chloride (0.054 g, 0.222 mmol, 1.05 eq.). The mixture was shaken at room temperature for 18 hours. The solvent was removed *in vacuo* and the residue dissolved in AcOEt. The AcOEt was washed with saturated aqueous NaHCO<sub>3</sub>, separated, dried (Na<sub>2</sub>SO<sub>4</sub>) and concentrated *in vacuo*. The residue was purified by MS-directed prep HPLC to yield the sulphonamide (3.1 mg).

LCMS R<sub>t</sub> 11.15 min.; *m/z* — 374; Purity -95%.

**Example 9****4-bromo-N-[4-(dimethylamino)phenyl]benzenesulphonamide**

To a solution of 4-dimethyl amino aniline (2 g, 0.0147 mol) and triethylamine (2.25 mL, 0.0162 mol, 1.1 eq.) in acetonitrile (20 mL) at 0°C under nitrogen was added 4-bromo-benzene sulphonyl chloride (3.94 g, 0.0154 mol, 1.05 eq.). The mixture was cooled to 0°C for 30 mins, and then allowed to warm to room temperature. The reaction was stirred for 18 hours. The solvent was removed *in vacuo* and the residue redissolved in ethyl acetate (100 mL). The organic layer was washed with sat aqueous NaHCO<sub>3</sub> (2x200 mL), water (2x200 mL), brine (200 mL), separated, dried (Na<sub>2</sub>SO<sub>4</sub>), filtered and concentrated *in vacuo*. The residue was dissolved in DCM, filtered through a pad of silica and the pad washed twice with DCM (100 ml). The filtrates were combined and concentrated *in vacuo*. The sulphonamide was obtained as a orange coloured solid (4.0 g, 76.6 %).

<sup>1</sup>H NMR (300 MHz CDCl<sub>3</sub>) δ 7.47 (s, 4H), 6.83 — 6.71 (d, 2H), 6.50 — 6.46 (d, 2H), 6.31 (b s, 1H), 2.83 (s, 6H); <sup>13</sup>C NMR (300 MHz CDCl<sub>3</sub>) δ 149.92, 138.83, 132.47, 129.32, 128.00, 126.77, 124.40, 113.07, 40.86; LCMS R<sub>t</sub> 11.57 min.; *m/z* — 356:358 (1:1 ratio).

**Example 10****N-[4-(dimethylamino)phenyl]-4-(1-naphthyl)benzenesulfonamide**

4-bromo-N-[4-(dimethylamino)phenyl]benzenesulphonamide (25 mg, 0.07 mmol) and 1-naphthyl boronic acid (17.2 mg, 0.07 mmol, 1 eq.) was dissolved in toluene (2 ml) under N<sub>2</sub>. Saturated aqueous Na<sub>2</sub>CO<sub>3</sub> (1 ml) was added followed by palladium tetrakis(triphenylphosphine) (1 mg, cat.). The reaction was refluxed for 4 hrs and then left to stirring at room temperature for 18 hrs. The reaction was diluted with AcOEt (4 ml) and the organic layer decanted off. The organic layer was filtered through a pad of celite and the solvent removed *in vacuo*. The residue was analysed by LCMS and confirmed to be the sulphonamide product (17.2 mg, 60.4%).

LCMS R<sub>t</sub> 12.91 min.; *m/z* — 404; Purity -95%.

The compounds of example 11 to 37 were prepared according to the following general coupling procedure.

**General Coupling Procedure 1: Coupling of sulfonyl chloride to amine in acetonitrile**

To a stirred solution of the amine (0.75 mmol) and triethylamine (0.75 mmol) in anhydrous acetonitrile (1 ml) at 0 °C was added 2, 4-dichlorobenzenesulphonyl chloride (0.50 mmol) in acetonitrile (1 ml). The mixture was stirred at this temperature for 2-3 hours and/or warmed up to ambient temperature and stirred until reaction had completed by TLC.

The solvent was removed *in vacuo* and the residue partitioned between ethyl acetate (25 ml) and saturated aqueous sodium bicarbonate solution (25 ml). The organic layer was separated and further washed with sodium bicarbonate (2x25ml), brine (2x25ml), dried over sodium sulphate and concentrated down. The product was purified either by flash chromatography or preparative HPLC.

**Example 11****NCE131 2,4-Dichloro-N-(2-methyl-1H-indol-5-yl)-benzenesulfonamide**

Synthesised according to general coupling procedure 1 and purified by flash chromatography.

<sup>1</sup>H NMR (300 MHz; CDCl<sub>3</sub>) 2.38 (3H, s, 2'-CH<sub>3</sub>), 6.11 (1H, m, 3'-H), 6.84 (1H, dd, J 2.1 and 8.5 Hz), 6.96 (1H, s), 7.09 (1H, d, J 8.5 Hz), 7.16 (1H,



dd, J 2.0 and 8.5 Hz), 7.23 (1H, d, J 2.0 Hz), 7.50 (1H, d, J 2.0 Hz), 7.77 (1H, d, J 8.5 Hz), 7.93 (1H, br, N-H)

$^{13}\text{C}$  NMR (300 MHz,  $\text{CDCl}_3$ ) 13.69 ( $\text{CH}_3$ ), 100.66 ( $3'\text{-CH}$ ), 110.75 ( $\text{CH}$ ), 115.44 ( $\text{CH}$ ), 117.83 ( $\text{CH}$ ), 127.14, 127.45 ( $\text{CH}$ ), 129.35, 131.17 ( $\text{CH}$ ),  
5 132.24, 132.99 ( $\text{CH}$ ), 134.74, 135.07, 136.80, 139.51

Actual Mass: 354.95

LCMS: Mass detected  $[\text{M-H}]^-$  353.00; Retention time 17.2 mins; Purity 87%

### Example 12

#### 10 NCE132 2,4-Dichloro-N-(2-methyl-benzothiazol-5-yl)-benzenesulfonamide

Synthesised according to general coupling procedure 1 and purified by flash chromatography.

$^1\text{H}$  NMR (300 MHz;  $\text{CDCl}_3$ ) 2.79 (3H, s,  $2'\text{-CH}_3$ ), 7.18-7.28 (3H, m,  $3\times\text{Ar-H}$ ), 7.49 (1H, d, J 2.0 Hz), 7.67 (1H, d, J 8.6 Hz), 7.94 (1H, d, J 11.5 Hz)

$^{13}\text{C}$  NMR (300 MHz,  $\text{CDCl}_3$ ) 20.19 ( $\text{CH}_3$ ), 115.59 (CH), 119.82 (CH), 122.13 (CH), 127.65 (CH), 131.46 (CH), 132.26, 133.04 (CH), 133.44, 134.61, 140.08, 153.89, 169.12

Actual Mass: 404.85

20 LCMS: Mass detected  $[\text{M-H}]^-$  402.85; Retention time 16.6 mins; Purity 96%

### Example 13

#### 25 NCE133 2,4-Dichloro-N-(2-methyl-benzothiazol-6-yl)-benzenesulfonamide

Synthesised according to general coupling procedure 1 and purified by flash chromatography.

$^1\text{H}$  NMR (300 MHz;  $\text{CDCl}_3$ ) 2.78 (3H, s,  $2'\text{-CH}_3$ ), 7.12 (1H, dd, J 2.2 and 8.7 Hz), 7.15 (1H, br, N-H), 7.27 (1H, dd, J 2.0 and 8.5 Hz), 7.52 (1H, d, J 2.0 Hz), 7.67 (1H, d, J 2.2 Hz), 7.76 (1H, d, J 8.7 Hz), 7.88 (1H, d, J 8.5 Hz)

30 Actual Mass: 373.00

LCMS: Mass detected  $[\text{M-H}]^-$  370.95; Retention time 13.2 mins; Purity 97%

**Example 14****NCE134 2,4-Dichloro-N-(1H-indol-5-yl)-benzenesulfonamide**

Synthesised according to general coupling procedure 1 and purified by flash chromatography.

5  $^1\text{H}$  NMR (300 MHz;  $\text{CDCl}_3$ ) 2.04 (3H, s, 2'- $\text{CH}_3$ ), 6.45-6.46 (1H, m), 6.94 (1H, dd, J 2.0 and 8.6 Hz), 7.00 (1H, s), 7.17-7.25 (3H, m), 7.38 (1H, d, J 1.6 Hz), 7.52 (1H, d, J 2.0 Hz), 7.80 (1H, d, J 8.5 Hz), 8.25 (1H, br, N-H)

Actual Mass: 341.00

LCMS: Mass detected  $[\text{M}-\text{H}]^-$  339.05; Retention time 13.2 mins; Pu-  
10 rity 96%

**Example 15****NCE138 2,4-Dichloro-N-(benzothiazol-6-yl)-benzenesulfonamide**

Synthesised according to general coupling procedure 1 and purified by flash chromatography.

15  $^1\text{H}$  NMR (300 MHz;  $\text{CDCl}_3$ ) 7.22 (1H, dd, J 2.2 and 8.7 Hz), 7.28 (1H, dd, J 2.0 and 8.5 Hz), 7.51 (1H, d, J 2.0 Hz), 7.56 (1H, br, N-H), 7.82 (1H, d, J 2.1 Hz), 7.94 (2H, dd, J 8.7 and 13.3 Hz), 8.94 (1H, s, 2'-H)

Actual Mass: 358.90

LCMS: Mass detected  $[\text{M}-\text{H}]^-$  356.90; Retention time 12.2 mins; Pu-  
20 rity 88%

**Example 16****NCE139 N-Benzothiazol-6-yl-3-bromo-benzenesulfonamide**

Synthesised according to general coupling procedure 1 and purified by flash chromatography.

25 NMR-To be purified and determined.

Actual Mass: 369

LCMS: No ionization; Retention time 10.3 mins; Purity 93%

**Example 17****NCE140 3-Bromo-N-(2-methyl-benzothiazol-5-yl)-benzenesulfonamide**

Synthesised according to general coupling procedure 1 and purified by flash chromatography.

- 5  $^1\text{H}$  NMR (300 MHz;  $\text{CDCl}_3$ ) 2.80 (3H, s, 2'-CH<sub>3</sub>), 7.18 (1H, dd, J 2.1 and 8.6Hz), 7.26 (1H, dd, J 2.7 and 10.6Hz), 7.33 (1H, br, N-H), 7.60-7.72 (4H, m, 4xAr-H), 7.94 (1H, m, Ar-H)

Actual Mass: 383

LCMS: No ionization; Retention time 17.1 mins; Purity 93%

10 **Example 18**

**NCE156 2,4-Dichloro-N-(2-methyl-benzooxazol-5-yl)-benzenesulfonamide**

Synthesised according to general coupling procedure 1 and purified by flash chromatography.

- 15  $^1\text{H}$  NMR (300 MHz;  $\text{CDCl}_3$ ) 2.59 (3H, s, 2'-CH<sub>3</sub>), 7.07 (1H, br, N-H), 7.11 (1H, dd, J 2.2 and 8.6 Hz), 7.24 (1H, dd, J 2.0 and 8.6 Hz), 7.34 (1H, d, J 8.6 Hz), 7.38 (1H, d, J 2.0 Hz), 7.52 (1H, d, J 2.0 Hz), 7.84 (1H, d, J 8.6 Hz)

Actual Mass: 356.80

- LCMS: Mass detected  $[\text{M}-\text{H}]^-$  355.00; Retention time 17.6 mins; Purity 80%

**Example 19****NCE157 N-Benzo[1,3]dioxol-5-yl-2,4-dichloro-benzenesulfonamide**

Synthesised according to general coupling procedure 1 and purified by flash chromatography.

- 25  $^1\text{H}$  NMR (300 MHz;  $\text{CDCl}_3$ ) 5.92 (2H, s, 2'-CH<sub>2</sub>), 6.50 (1H, dd, J 2.1 and 8.3 Hz), 6.61 (1H, d, J 8.3 Hz), 6.70 (1H, d, J 2.1 Hz), 6.93 (1H, br, N-H), 7.30 (1H, dd, J 2.2 and 8.5 Hz), 7.53 (1H, d, J 2.0 Hz), 7.86 (1H, d, 8.5 Hz)

Actual Mass: 345.95

- LCMS: Mass detected  $[\text{M}-\text{H}]^-$  343.80; Retention time 14.3 mins; Purity 97%

**Example 20****NCE158 3-Bromo-N-(2-methyl-benzooxazol-5-yl)-benzenesulfonamide**

Synthesised according to general coupling procedure 1 and purified by flash chromatography.

5  $^1\text{H}$  NMR (300 MHz;  $\text{CDCl}_3$ ) 2.62 (3H, s, 2'-CH<sub>3</sub>), 6.70 (1H, br, N-H), 7.06 (1H, dd, J 2.2 and 8.6 Hz), 7.25-7.31 (2H, m 2xAr-H), 7.37 (1H, d, J 8.6 Hz), 7.59-7.64 (2H, m, 2xAr-H), 7.90 (1H, t, J 1.8 Hz)

Actual Mass: 367.00

LCMS: Mass detected [M-H]<sup>-</sup> 365.00; Retention time 11.1 mins; Purity 86%

**Example 21****NCE159 N-Benzo[1,3]dioxol-5-yl-3-bromo-benzenesulfonamide**

Synthesised according to general coupling procedure 1 and purified by flash chromatography.

15  $^1\text{H}$  NMR (300 MHz;  $\text{CDCl}_3$ ) 5.95 (2H, s, 2'-CH<sub>2</sub>), 6.44 (1H, dd, J 2.2 and 8.3 Hz), 6.65 (1H, d, J 8.3 Hz), 6.67 (1H, d, J 2.2 Hz), 6.80 (1H, br, N-H), 7.32 (1H, t, J 7.9 Hz), 7.65 (2H, dt, J 0.9 and 7.9 Hz), 7.90 (1H, t, J 1.8 Hz)

Actual Mass: 356.00

LCMS: Mass detected [M-H]<sup>-</sup> 353.95; Retention time 13.4 mins; Purity 98%

**Example 22****NCE-160 2,4-Dichloro-N-(2-methyl-benzooxazol-6-yl)-benzenesulfonamide**

25 Synthesised according to general coupling procedure 1 and purified by flash chromatography.

$^1\text{H}$  NMR (300 MHz;  $\text{CDCl}_3$ ) 2.59 (3H, s, 2'-CH<sub>3</sub>), 7.00 (1H, dd, J 3.1 and 6.4 Hz), 7.26 (1H, dd, J 2.0 and 8.5 Hz), 7.39 (1H, d, J 2.0 Hz), 7.43 (1H, d, J 4.7 Hz), 7.49 (1H, d, J 2.0 Hz), 7.67 (1H, br, N-H), 8.17 (1H, d, J 8.5 Hz)

Actual Mass: 357.00

30 LCMS: Mass detected [M-H]<sup>-</sup> 355.00; Retention time 11.7 mins; Purity 99%

**Example 23****NCE 169 3-Bromo-N-(2-methyl-benzooxazol-6-yl)-benzenesulfonamide**

Synthesised according to general coupling procedure 1 and purified by flash chromatography.

5 <sup>1</sup>H NMR (300 MHz; CDCl<sub>3</sub>) 2.62 (3H, s, 2'-CH<sub>3</sub>), 6.91 (1H, dd, J 2.0 and 8.4 Hz), 7.28 (1H, t, J 7.9 Hz), 7.38-7.40 (2H, m), 7.47 (1H, d, J 8.5 Hz), 7.61-7.66 (2H, m), 7.9 (1H, t, J 1.8 Hz)

Actual Mass: 366.95

LCMS: Mass detected [M-H]<sup>+</sup> 364.90; Retention time 10.6 mins; Pu-  
10 rity 89%

**Example 24****NCE161 2,4-Dichloro-N-(1H-indol-6-yl)-benzenesulfonamide**

Synthesised according to general coupling procedure 1 and purified by flash chromatography.

15 <sup>1</sup>H NMR (300 MHz; CDCl<sub>3</sub>) 6.47 (1H, m), 6.76 (1H, dd, J 1.9 and 8.4 Hz), 7.50 (1H, s), 7.18-7.26 (3H, m), 7.32 (1H, s), 7.44 (1H, d, J 8.4 Hz), 7.51 (1H, d, J 2.0 Hz), 7.82 (1H, d, J 8.5 Hz), 8.21 (1H, br, N-H)

Actual Mass: 341.05

LCMS: Mass detected [M-H]<sup>+</sup> 339.05; Retention time 14.1 mins; Pu-  
20 rity 99%

**Example 25****NCE162 3-Bromo-N-(1H-indol-6-yl)-benzenesulfonamide**

Synthesised according to general coupling procedure 1 and purified by flash chromatography.

25 <sup>1</sup>H NMR (300 MHz; CDCl<sub>3</sub>) 6.51 (1H, m), 6.57 (1H, s), 6.64 (1H, dd, J 1.9 and 8.4 Hz), 7.22 (1H, dd, J 2.4 and 5.6 Hz), 7.33 (1H, s), 7.47 (1H, d, J 8.4 Hz), 7.55-7.62 (2H, m), 7.91 (1H, t, 1.8 Hz), 8.22 (1H, br, N-H)

Actual Mass: 350.90

LCMS: Mass detected [M-H]<sup>+</sup> 348.90; Retention time 12.9 mins; Pu-  
30 rity 98%

**Example 26****NCE 130 4-Bromo-2-chloro-N-(4-dimethylamino-phenyl)-benzenesulfonamide**

Synthesised according to general coupling procedure 1 and purified  
5 by flash chromatography.

$^1\text{H}$  NMR 300 MHz;  $\delta_{\text{H}}$  ( $\text{CDCl}_3$ ) 7.73 (1H, d,  $J$  8.4Hz, ArH), 7.69 (1H, d,  $J$  2.0Hz, ArH), 7.41 (1H, dd,  $J$  2.0, 8.4Hz, ArH), 6.97 (2H, d,  $J$  8.8Hz, ArH), 6.54 (2H, d,  $J$  8.8Hz, ArH), 2.90 (6H, s,  $\text{N}(\text{CH}_3)_2$ ).

ESMS +ve calculated 389.7,  $[\text{M}+\text{H}]^+$  389.17. Purity Estimated >90%

10 **Example 27**

**NCE 141 4-Bromo-N-(2,4-dichloro-phenyl)-benzenesulfonamide**

Synthesised according to general coupling procedure 1 and purified  
by flash chromatography.

$^1\text{H}$  NMR 400 MHz  $\delta_{\text{H}}$  (DMSO) 7.93 (4H, m, ArH), 7.75 (2H, dd,  $J$  2.0, 7.2 Hz),  
15 7.32 (1H,  $J$  7.2Hz, ArH).

Actual Mass: 381.08

LCMS: Mass detected  $[\text{M}-\text{H}]^-$  no ionisation; Retention time 16.25  
mins; Purity 95.2%

**Example 28**

20 **NCE 167 4-Bromo-N-(3,4-dichloro-phenyl)-benzenesulfonamide**

Synthesised according to general coupling procedure 1 and purified  
by flash chromatography.

$^1\text{H}$  NMR 400 MHz  $\delta_{\text{H}}$  (DMSO) 7.92 (2H, d,  $J$  8.8Hz, ArH), 7.67 (2H, d,  $J$  8.8Hz,  
ArH). 7.66 (1H, d, ArH), 7.50 (1H, d,  $J$  2.0Hz, ArH), 7.04 (1H, dd,  $J$  2.0, 7.6Hz,  
25 ArH).

Actual Mass: 381.08

LCMS: Mass detected  $[\text{M}-\text{H}]^-$  380.10; Retention time 21.57 mins;  
Purity 92.1%

**Example 29****NCE 135 [4-(2,4-Dichloro-benzenesulfonylamino)-phenyl]-(4,6-dimethyl-pyrimidin-2-yl)-methyl-ammonium; chloride**

NCE 50 2,4-dichloro-N-{4-[(4,6-dimethyl-pyrimidin-2-yl)-methyl-amino]-phenyl}-benzenesulfonamide (75mg, 1.7mM) was dissolved in ethyl acetate (10ml) with stirring. To this solution was carefully added a solution of 2M hydrochloric acid in diethyl ether (1ml). A white precipitate is then observed. This solid was filtered off, washed with diethyl ether and dried under high vacuum. The salt produced was redissolved in distilled water with a minimum of acetonitrile to ensure complete solubility and freeze dried to yield an off white solid.

$^1\text{H}$  NMR 300 MHz  $\delta_{\text{H}}$  ( $\text{CD}_3\text{OD}$ ) 9.37 (1H, d,  $J$  8.4Hz, ArH), 8.98 (1H, d,  $J$  2.0Hz, ArH), 8.83 (1H, dd,  $J$  2.0, 8.4Hz, ArH), 8.57 (4H, m, ArH), 7.94 (1H, s, Pyrimidyl), 3.50 (6H,  $\text{ArCH}_3$ ).

Purity Estimated >90%

**Example 30****NCE 136 Methanesulfonate[4-(2,4-dichloro-benzenesulfonylamino)-phenyl]-(4,6-dimethyl-pyrimidin-2-yl)-methyl-ammonium**

NCE 50 2,4-dichloro-N-{4-[(4,6-dimethyl-pyrimidin-2-yl)-methyl-amino]-phenyl}-benzenesulfonamide (75mg, 1.7mM) was dissolved in ethyl acetate (10ml) with stirring. To this solution is added a solution of methane sulfonic acid in ethyl acetate (1M, 2ml), this solution was then evacuated to dryness to yield a light brown oil. The oil was repeatedly suspended in dry diethyl ether and the solvent decanted off to remove excess acid. The salt produced was the redissolved in distilled water with a minimum of acetonitrile to ensure complete solubility and freeze dried to yield a brown oil.

$^1\text{H}$  NMR 300 MHz  $\delta_{\text{H}}$  ( $\text{CD}_3\text{OD}$ ) 9.46 (1H, d,  $J$  8.4Hz, ArH), 9.01 (1H, d,  $J$  2.0Hz, ArH), 8.88 (1H, dd,  $J$  2.0, 8.4Hz, ArH), 8.74 (2H, d, ArH), 8.66 (2H, d, ArH), 8.24 (1H, s, Pyrimidyl), 4.83 (3H, s), 3.75 (6H,  $\text{ArCH}_3$ ).

Purity Estimated >90%

**Example 31****NCE 142 [4-(3',4'-Dimethoxy-biphenyl-3-sulfonylamino)-phenyl]-dimethyl-ammonium; chloride**

Procedure used identical to that for NCE 135 using NCE 102 as the starting material.

$^1\text{H}$  NMR 400 MHz  $\delta_{\text{H}}$  ( $\text{CDCl}_3$ ) 7.94 (1H, s, ArH), 7.89 (1H, d,  $J$  7.6Hz, ArH), 7.65 (1H, d,  $J$  7.6Hz, ArH), 7.58 (1H, t,  $J$  7.6Hz, ArH), 7.05-7.16 (7H, m, ArH), 3.83 (3H, s,  $\text{OCH}_3$ ), 3.79 (3H, s,  $\text{OCH}_3$ ), 2.92 (6H, s,  $\text{N}(\text{CH}_3)_2$ )

Purity Estimated >90%

**Example 32****NCE 137 4-Bromo-2-chloro-N-{4-[(4,6-dimethyl-pyrimidin-2-yl)-methyl-amino]-phenyl}-benzenesulfonamide**

Synthesised according to general coupling procedure 1 and purified by flash chromatography

$^1\text{H}$  NMR 400 MHz  $\delta_{\text{H}}$  ( $\text{CDCl}_3$ ) 7.78 (1H, d,  $J$  8.8 Hz, ArH), 7.69 (1H, s), 7.48 (1H, d,  $J$  8.8Hz, ArH), 7.25 (2H, d,  $J$  8.7Hz, ArH), 7.06 (2H, d,  $J$  8.7Hz, ArH), 6.37 (1H, s, Pyrimidyl), 3.48 (3H, s), 2.25 (6H, s).

Actual Mass: 481.80

LCMS: Mass detected  $[\text{M}-\text{H}]^-$  481.30; Retention time 16.58 mins;

Purity 96.6%

**Example 33****NCE 164 2,4-Dichloro-N-[4-(4,6-dimethoxy-pyrimidin-2-yl)-phenyl]-benzenesulfonamide**

Synthesised according to general coupling procedure 1 and purified by flash chromatography.

$^1\text{H}$  NMR 300 MHz  $\delta_{\text{H}}$  ( $\text{CDCl}_3$ ) 8.6 (2H, d,  $J$  7.6Hz, ArH), 7.98 (1H, d,  $J$  8.5Hz, ArH), 7.49 (1H, d,  $J$  2.0Hz, ArH), 7.30 (1H, dd,  $J$  2.0, 8.5Hz, ArH), 7.18 (2H, d,  $J$  7.5Hz, ArH), 7.14 (1H, br s, NH), 5.93 (1H, s, Pyrimidyl), 4.00 (6H, s,  $\text{OCH}_3$ ).

Actual Mass: 440.30

LCMS: Mass detected  $[\text{M}-\text{H}]^-$  No Ionisation; Retention time 16.04 mins; Purity 96.9%



**Example 34****NCE 165 2,4-Dichloro-N-[4-(4,6-dimethyl-pyrimidin-2-yloxy)-phenyl]-benzenesulfonamide**

Synthesised according to general coupling procedure 1 and purified  
5 by flash chromatography.

<sup>1</sup>H NMR 300 MHz  $\delta_H$  (CDCl<sub>3</sub>) 7.91 (1H, d, *J* 8.5Hz, ArH), 7.54 (1H, d, *J* 2.0Hz, ArH), 7.31 (1H, dd, *J* 2.0, 8.5Hz, ArH), 7.12 (4H, m, AB d), 6.96 (1H, br s, NH), 6.76 (1H, s, pyrimidyl), 2.37 (6H, s).

Actual Mass: 424.31

10 LCMS: Mass detected [M-H]<sup>-</sup> 422.40; Retention time 13.59 mins;  
Purity 97.0%

**Example 35****NCE 168 2,4-Dichloro-N-[4-(4,6-dimethyl-pyrimidin-2-ylsulfonyl)-phenyl]-benzenesulfonamide**

15 Synthesised according to general coupling procedure 1 and purified  
by flash chromatography.

<sup>1</sup>H NMR 400 MHz  $\delta_H$  (CDCl<sub>3</sub>) 7.95 (1H, d, *J* 8.5Hz, ArH), 7.49 (1H, d, *J* 2.0Hz, ArH), 7.45 (1H, d, *J* 8.4Hz, ArH), 7.30 (1H, dd, *J* 2.0, 8.4Hz, ArH), 7.11 (2H, d, *J* 8.4Hz, ArH), 6.67 (1H, br s, NH), 2.27 (6H, s, CH<sub>3</sub>)

20 Actual Mass: 440.37

LCMS: Mass detected [M-H]<sup>-</sup> 438.40; Retention time 16.25 mins;  
Purity >95%

**Example 36****NCE 163 2,4-Dichloro-N-(4-pyrrol-1-yl-phenyl)-benzenesulfonamide**

25 Synthesised according to general coupling procedure 1 and purified  
by prep HPLC.

<sup>1</sup>H NMR 300 MHz  $\delta_H$  (CDCl<sub>3</sub>) 7.90 (1H, d, *J* 8.4Hz, ArH), 7.54 (1H, d, *J* 2.0Hz, ArH), 7.30 (1H, dd, *J* 2.0, 8.4Hz, ArH), 7.25 (2H, d, ArH), 7.17 (2H, d, ArH), 6.98 (2H, t, *J* 2.0Hz, Pyrrole), 6.31 ((2H, t, *J* 2.0Hz, Pyrrole).

30 Actual Mass: 367.27

LCMS: Mass detected [M-H]<sup>-</sup> 365.20; Retention time 16.55 mins;  
Purity 96.8%

**Example 37****NCE 166 Biphenyl-3-sulfonic acid (4-dimethylamino-phenyl)-amide**

Synthesised according to general coupling procedure 1 and purified by Prep HPLC.

- 5  $^1\text{H}$  NMR 400 MHz  $\delta_{\text{H}}$  ( $\text{CDCl}_3$ ) 7.82 (1H, t, ArH), 7.73 (1H, td,  $J$  7.8Hz, ArH), 7.64 (1H, td,  $J$  7.8Hz, ArH), 7.33-7.49 (6H, m, ArH), 6.90 (2H, d,  $J$  8.8Hz, ArH), 6.56 (2H, d, ArH), 6.12 (1H, br s, ArH), 2.90 (6H, s,  $\text{N}(\text{CH}_3)_2$ ).

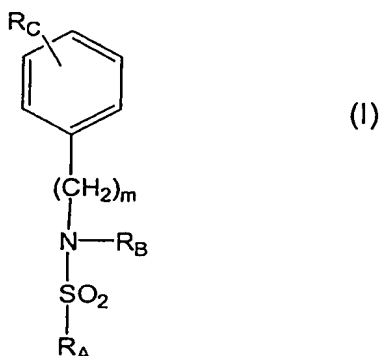
Actual Mass: 352.46

LCMS: Mass detected  $[\text{M}-\text{H}]^-$  351.4.; Retention time mins; Purity

- 10 98.5 %

## Claims

1. A sulphonamide derivative of formula (I),



where

$R_C$  is an optionally substituted 4-6-membered heterocyclic ring containing one or more N atoms, or  $R_C$  is  $-NR^1R^2$ , where

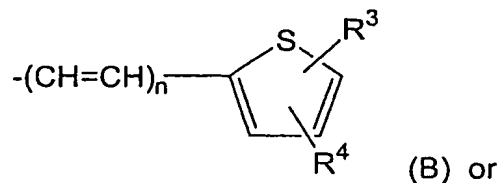
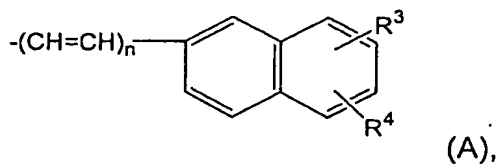
$R^1$  is hydrogen or alkyl,

$R^2$  is alkyl or an optionally substituted 4-6-membered heterocyclic ring containing one or more N atoms, or

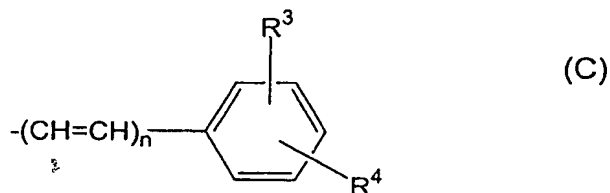
$R^1$  and  $R^2$  taken together with the nitrogen atom to which they are attached form a heterocyclic group, which may contain one or more additional heteroatoms selected from O and N and which may be substituted, or

$R^1$  and  $R^2$  are absent and the nitrogen atom together with the adjacent carbon atom forms a heterocyclic ring, which may contain one or more additional heteroatoms selected from N and S and which may be substituted,

$R_A$  is a group having the formula



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wherein

n is 0 or 1, and

R<sup>3</sup> and R<sup>4</sup> represent each independently hydrogen, halogen, aryl, alkoxy, carboxy, hydroxy, alkoxyalkyl, alkoxycarbonyl, cyano, trifluoromethyl, alkanoylamino, trifluoromethoxy, an optionally substituted aryl or heterocyclic group.

2. A derivative according to claim 1 where R<sup>1</sup> and R<sup>2</sup> represent methyl, R<sup>3</sup> is 2-chloro and R<sup>4</sup> is 4-chloro.

3. A derivative according to claim 1 where R<sup>1</sup> is hydrogen, R<sup>2</sup> is 4,6-dimethylpyrimidin-2-yl, R<sup>3</sup> is chloro and R<sup>4</sup> is chloro.

4. A derivative according to claim 1 where R<sup>1</sup> and R<sup>2</sup> represent methyl, R<sup>3</sup> is hydrogen and R<sup>4</sup> is 3,4-dimethoxyphenyl.

5. A derivative according to claim 1 where R<sup>1</sup> and R<sup>2</sup> represent methyl, R<sup>3</sup> is hydrogen and R<sup>4</sup> is 4-fluorophenyl.

6. A derivative according to claim 1 where R<sup>1</sup> and R<sup>2</sup> represent methyl, R<sup>3</sup> is hydrogen and R<sup>4</sup> is bromo.

7. A derivative according to any of claims 1 to 6 for use as an inhibitor for collagen receptor integrins.

8. A derivative according to any of the claims 1 to 6 for use as an inhibitor for  $\alpha 2\beta 1$  integrin.

9. A derivative according to any of claims 1 to 6 for use as an  $\alpha 2\beta 1$  integrin I domain inhibitor.

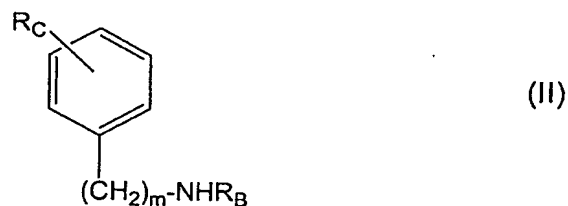
10. A derivative according to any of claims 1 to 6 for use as a medicament.

11. A derivative according to claim 10 for use as a medicament for treating thrombosis and cancer spread.

12. The use of a derivative according to any of claims 1 to 6 for preparing a pharmaceutical composition for treating disorders relating to thrombosis and cancer spread.

13. A pharmaceutical composition comprising an effective amount of a derivative according to any of claims 1 to 6 in admixture with a pharmaceutically acceptable carrier.

14. A process for preparing a benzene sulphonamide according to claim 1, comprising reacting a compound of formula (II)



where  $R_B$ ,  $R_C$  and  $m$  are as defined above, with a compound of formula (III)

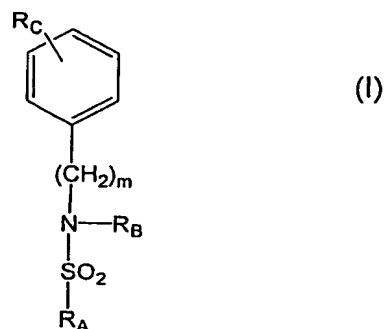


where  $R_A$  is as defined above and hal is halogen.

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**(57) Abstract**

The invention relates to sulphonamide derivatives of formula (I),



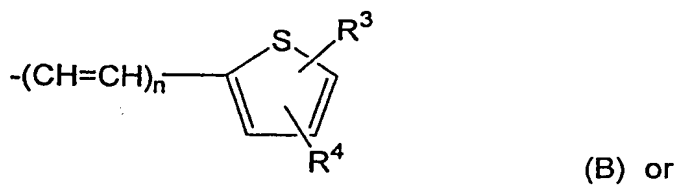
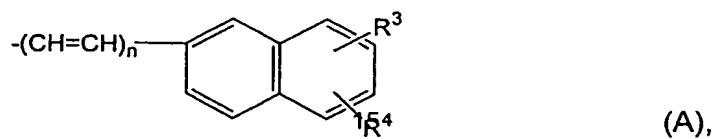
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where

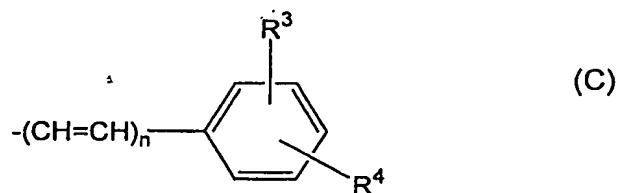
$R_C$  is optionally substituted 4-6-membered heterocyclic ring containing one or more N atoms, or

$R_C$  is  $-NR^1R^2$ ,

10  $R_A$  is a group having the formula

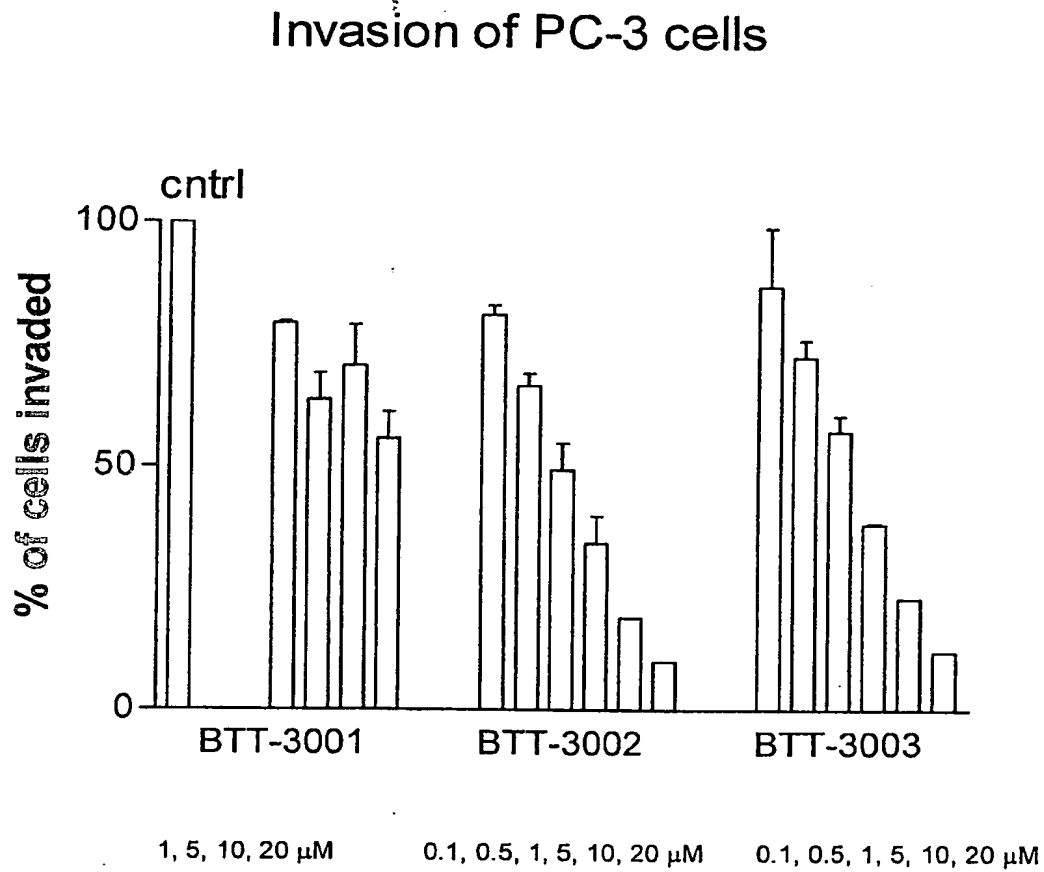


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R<sub>8</sub> is hydrogen or alkyl.

The invention also relates to the use of derivatives of formula (I) as inhibitors for collagen receptor integrins and a process for preparing sulphonamides of formula (I).

**Fig 1** Invasion of PC-3 (prostate cancer) cell line through Matrigel



**Fig 2** Representative result from PFA100 analysis

